Contact Lens Health Week — August 21–25, 2017

August 21–25, 2017, marks the fourth annual Contact Lens Health Week. In collaboration with partners from the clinical, public health, industry, and regulatory sectors, CDC is promoting healthy wear and care practices to reduce the risk for eye infections among the approximately 45 million persons in the United States who wear contact lenses. Research after outbreaks of rare but serious eye infections in the United States has indicated that these infections occur most often in contact lens wearers who do not take proper care of their contact lenses, indicating a need to promote safer wear and care (1,2).

A report in this issue of *MMWR* describes CDC's first-ever population-based estimates of contact lens–related risk behaviors in persons aged 12–17 years (referred to here as adolescents) in the United States. Approximately six in seven adolescents reported at least one behavior (e.g., sleeping in lenses, swimming, or not replacing lenses and storage cases as recommended) putting them at risk for a serious contact lens–related eye infection. Encouraging adolescents to adopt healthy contact lens wear and care habits might help them maintain healthy habits into adulthood.

Although most contact lens wearers receive the benefits of vision correction, contact lenses can pose an infection risk, especially if they are not worn and cared for properly. Practicing proper contact lens hygiene and regularly visiting an eye care provider are important behaviors for keeping contact lens wearers' eyes healthy. Additional information on Contact Lens Health Week and the proper wear and care of contact lenses is available at https://www.cdc.gov/contactlenses.

References

1. Verani JR, Lorick SA, Yoder JS, et al.; Acanthamoeba Keratitis Investigation Team. National outbreak of *Acanthamoeba* keratitis associated with use of a contact lens solution, United States. Emerg Infect Dis 2009;15:1236–42. https://doi.org/10.3201/eid1508.090225.
2. Chang DC, Grant GB, O'Donnell K, et al.; Fusarium Keratitis Investigation Team. Multistate outbreak of *Fusarium* keratitis associated with use of a contact lens solution. JAMA 2006;296:953–63. https://doi.org/10.1001/jama.296.8.953.

Risk Behaviors for Contact Lens–Related Eye Infections Among Adults and Adolescents — United States, 2016

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Contact lens–related eye infections, which can lead to serious outcomes, including blindness, are associated with several risk factors, including sleeping in lenses, exposing lenses to water, not adhering to replacement schedules, and reusing disinfecting solution (1). In some studies, adolescent and young adult contact lens wearers have been reported to be more likely than older adult contact lens wearers to develop eye infections (2,3) and more likely to have poor contact lens hygiene practices (2).

Continuing Education examination available at https://www.cdc.gov/mmwr/cme/conted_info.html#weekly.

In 2015, CDC reported the number and demographics of adult contact lens wearers in the United States to define the population at risk for contact lens–related eye infections (4); however, this estimate did not include adolescents. To better understand this group of younger contact lens wearers and guide prevention efforts, a population-based survey was used to assess contact lens wear, care behaviors, risk factors, and demographics among persons aged 12–17 years (referred to as adolescents in this report), young adults aged 18–24 years, and older adults aged ≥25 years in the United States. In 2016, an estimated 3.6 million adolescents (14.5%) wore contact lenses. Of the adolescents who wore contact lenses, 85% reported at least one behavior that put them at risk for a contact lens–related eye infection, compared with 81% of young adults, and 88% of older adults. These findings can inform the creation of age-specific targeted prevention messages aimed at contact lens wearers and establish a baseline for evaluating trends in contact lens wear, care habits, and contact lens–related risk behaviors.

To describe contact lens wear and care behaviors, risk factors, and demographics for adolescents and adults in the United States, the Porter Novelli 2016 summer HealthStyles and YouthStyles survey, an online survey of 4,548 U.S. adults (aged ≥18 years) and 1,618 U.S. adolescents (aged 12–17 years) was used. Adolescent participants lived in the households of the adult participants.* The 2016 Porter Novelli Styles survey

* Porter Novelli Public Services. Summer HealthStyles and YouthStyles 2016 methodology; Washington, DC.

participants were part of the GfK KnowledgePanel, a nationally representative online panel with members recruited through probability-based sampling by postal address. Computer and Internet access were provided to complete the survey where needed. For completing this survey and others, households received rewards points, which they could redeem for prizes generally worth less than $500. The sample was weighted on nine factors (sex, age, household income, race/ethnicity, household size, education, census region, metropolitan status, and prior Internet access) to match the Current Population Survey conducted by the U.S. Census Bureau. Participants were asked to provide demographic and contact lens wearing information. If they wore contact lenses, they were asked about contact lens hygiene behaviors and risk factors associated with contact lens–related eye infections. The question regarding contact lens hygiene behaviors was "When you wear contact lenses, which of these actions do you do on a regular basis (sometimes, most of the time, or always)?"

In 2016, an estimated 3.6 million adolescents aged 12–17 years (14.5% of adolescents), 7.5 million young adults aged 18–24 years (24.4% of young adults), and 33.9 million older adults aged ≥25 years (15.5% of adults) in the United States wore contact lenses. Among lens wearers, 90.4% of adults and 87.8% of adolescents reported wearing soft contact lenses (lenses made of soft, flexible plastics that allow oxygen to pass through to the cornea). No significant demographic differences between adolescent contact lens wearers and adolescent nonwearers were observed (Table 1). By race, older adult

TABLE 1. Demographic characteristics of adolescent contact lens wearers (aged 12–17 years), by type of contact lens, compared with adolescent nonwearers, young adult lens wearers (aged 18–24 years), and older adult lens wearers (aged ≥25 years) — United States, 2016*

	% (95% CI)					
Characteristic	Adolescent soft CL wearers (n = 119)	Adolescent gas permeable or other[†] CL wearers (n = 16)	All adolescent CL wearers[§] (n = 135)	Adolescent nonwearers (n = 810)	Young adult CL wearers (n = 124)	Older adult CL wearers (n = 571)
Sex						
Female	52.6 (41.6–63.5)	48.2 (11.8–84.5)	52.3 (41.6–62.9)	48.8 (44.7–52.8)	69.3 (56.8–81.8)	65.2 (60.4–70.0)
Male	47.4 (36.5–58.4)	51.8 (15.5–88.2)	47.7 (37.1–58.4)	51.2 (47.2–55.3)	30.7 (18.2–43.2)	34.8 (30.0–39.6)
Race/Ethnicity						
White, non-Hispanic	49.9 (39.0–60.7)	42.3 (6.7–77.9)	48.4 (37.9–58.9)	55.0 (50.9–59.2)	56.7 (42.7–70.6)	66.9 (61.8–71.9)
Hispanic	26.6 (16.1–37.1)	15.7 (0.0–34.4)	25.6 (15.8–35.4)	22.4 (18.5–26.2)	21.1 (9.2–33.0)	11.4 (8.3–14.5)
Black, non-Hispanic	12.0 (3.4–20.6)	42.0 (4.9–79.2)	15.8 (6.4–25.2)	13.5 (10.4–16.6)	7.1 (0.6–13.6)	10.3 (7.2–13.4)
Other or multiracial	11.5 (3.9–19.2)	—	10.3 (3.4–17.2)	9.1 (6.7–11.5)	15.2 (3.3–27.0)	10.7 (6.5–14.9)
Metropolitan living area						
Metro	90.5 (84.8–96.3)	56.9 (18.5–95.3)	86.3 (78.1–94.5)	85.0 (81.8–88.1)	93.6 (86.2–100.0)	86.2 (82.7–89.7)
Nonmetro	9.5 (3.7–15.2)	43.1 (4.7–81.5)	13.7 (5.5–21.9)	15.0 (11.9–18.2)	6.4 (0.0–13.8)	13.8 (10.3–17.3)
Geographic region						
Northeast	16.2 (8.0–24.5)	11.6 (0.0–28.7)	15.9 (8.2–23.5)	16.9 (13.9–19.8)	27.5 (15.7–39.2)	17.7 (14.0–21.3)
Midwest	27.4 (18.9–35.9)	22.5 (0.0–50.8)	26.8 (18.5–35.1)	20.4 (17.3–23.4)	24.3 (12.7–35.9)	23.5 (19.4–27.5)
South	36.5 (25.8–47.2)	54.7 (19.8–89.7)	38.3 (27.6–48.9)	37.7 (33.7–41.7)	33.8 (20.6–47.0)	35.6 (30.9–40.4)
West	19.9 (10.5–29.3)	11.2 (0.0–27.1)	19.1 (10.4–27.7)	25.0 (21.3–28.7)	14.4 (4.3–24.6)	23.2 (18.9–27.5)

Abbreviations: CI = confidence interval; CL = contact lens.
* Based on responses to Porter Novelli 2016 summer HealthStyles and YouthStyles surveys with questions on contact lens use and wearer/nonwearer demographics.
[†] Other indicates contact lens wearers who said they wore a type of contact lens not included among the survey choices.
[§] Some individual columns do not sum to 100.0 because of rounding.

lens wearers were more likely to be white than were adolescent lens wearers. No significant geographic region or metropolitan residency differences were observed for either adolescents or adults, regardless of lens-wearing status.

At least one contact lens hygiene risk behavior was reported by older adult (87.5%), young adult (80.9%), and adolescent (85.3%) lens wearers (Table 2). The most frequently reported risk behaviors in adolescents were not visiting an eye doctor as least annually, sleeping or napping in lenses, and swimming in lenses (Table 2). Among young adults and older adults, the most frequently reported risk behaviors were replacing lenses at intervals longer than those prescribed, replacing lens storage cases at intervals longer than those recommended, swimming in lenses, and sleeping or napping in lenses. Adolescents were significantly less likely to report replacing lenses at intervals longer than prescribed and replacing lens storage cases at intervals longer than recommended. Although both adults and adolescents most commonly reported purchasing contact lenses through their eye care provider, both young adults and older adults were more likely than adolescents to purchase lenses on the Internet. A higher percentage of young adults (14.6%, 1.1 million) and older adults (11.4%, 3.9 million) than adolescents (4.2%, 152,000) reported ever experiencing a red or painful eye that required an eye care provider visit.

Discussion

An estimated one in seven adolescents and one in six adults in the United States wore contact lenses in 2016, and approximately six of seven lens wearers reported at least one behavior putting them at risk for a serious contact lens–related eye infection. Lens wearers most commonly reported sleeping or napping in lenses, swimming in lenses, and replacing both lenses and lens storage cases at intervals longer than those recommended.

A previous study suggested that adolescents and young adults have lower compliance with contact lens hygiene recommendations and have a greater risk for corneal inflammatory events, a category of eye problems that includes serious eye infections (3). Young adults in this survey were significantly more likely to replace lenses and cases at intervals longer than those recommended than were adolescents. These findings might reflect the fact that most adolescents are still living with their parents who might help to reinforce good contact lens hygiene practices whereas young adults might have recently left home and are no longer subject to parental reminders (2). Young adults also might have fewer resources (e.g., money and transportation) to regularly visit eye care providers and obtain hygiene education or regularly replace contact lenses, lens storage cases, and solution (3). Young adults have been reported to have poor planning and a more impulsive lifestyle in relation to contact lens hygiene, possibly related to crowded

TABLE 2. Prevalence of risk behaviors* for contact lens–related eye infections and outcomes among adolescent (aged 12–17 years), young adult (aged 18–24 years), and older adult (aged ≥25 years) contact lens wearers — United States, 2016

Characteristic	% (95% CI)		
	Adolescent CL wearers	Young adult CL wearers	Older adult CL wearers
Risk factor/Behavior			
Sleeping or napping in CLs	29.8 (19.7–40.0)	33.3 (20.9–45.7)	32.9 (28.3–37.5)
Topping off solution[†]	10.6 (4.9–16.2)	19.1 (8.4–29.8)	11.0 (7.8–14.3)
Replacing lenses at intervals longer than prescribed	23.7[§,¶] (14.7–32.6)	52.4 (38.8–66.1)	44.5 (39.7–49.4)
Did not visit eye doctor at least annually	43.9 (33.1–54.6)	24.0 (11.8–36.1)	29.6 (25.0–34.3)
Replacing CL case at interval longer than recommended	22.8[§,¶] (14.5–31.2)	40.5 (27.2–53.7)	41.7 (36.9–46.5)
Storing lenses in tap water	9.5 (3.3–15.7)	11.0 (2.1–19.9)	2.3 (0.8–3.8)
Rinsing lenses in tap water	7.1 (2.7–11.5)	12.1 (3.2–21.0)	6.2 (4.2–8.2)
Swimming in CLs	27.2 (18.4–36.0)	28.1 (16.3–40.0)	33.2 (28.7–37.7)
Any risk behavior	85.3 (78.7–91.9)	80.9 (70.0–91.8)	87.5 (84.2–90.7)
Source of purchase			
Eye care provider office	68.0 (58.2–77.9)	65.5 (52.7–78.4)	65.4 (60.6–70.2)
Retail store without eye exam	15.8 (9.4–22.2)	22.5 (11.4–33.7)	21.3 (17.1–25.5)
Internet	10.5 (5.1–15.8)	20.6 (9.6–31.5)	18.8 (14.9–22.6)
Other	3.6 (0.0–7.4)	—	1.7 (0.5–3.0)
Ever had a red/painful eye while wearing CLs that required a doctor visit	4.2 (0.7–7.8)	14.6 (5.1–24.1)	11.4 (8.1–14.8)

Abbreviations: CI = confidence intervals; CL = contact lens.
* As assessed by the question "When you wear contact lenses, which of these actions do you do on a regular basis (sometimes, most of the time, or always)?"
† Adding new solution to existing solution in the contact lens case instead of emptying and cleaning the case before adding new solution.
§ p-value <0.05 compared with young adult CL wearers.
¶ p-value <0.05 compared with older adult CL wearers.

living conditions (e.g., dormitories, living with roommates, and sharing bathrooms), alcohol consumption, and attitudes conducive to taking greater risks (2). A higher percentage of young adults also reported ever having a red or painful eye while wearing contact lenses, suggesting that poor hygiene practices might lead to complications.

Engaging in risky contact lens behaviors can lead to potentially serious eye infections (1). Substantial percentages of adults and adolescents reported noncompliance with recommended contact lens storage case and lens replacement schedules. Infrequent contact lens storage case replacement has been associated with microbial keratitis (5), and lens wearers who do not replace their lenses as often as recommended report more complications and eye discomfort (6). Not replacing contact lenses and contact lens storage cases as often as recommended increases the risk for contact lens–related eye infections because recurrent handling of the contact lenses and storage cases presents the opportunity to introduce microorganisms; in addition, the moist surfaces of the lens and storage case provide an environment favorable to microbial growth (7).

Exposing contact lenses to water through swimming or showering increases the risk for infection because microorganisms living in water can be transferred to the eye. Even household tap water, although safe for drinking, contains microorganisms that can contaminate lens cases and contact lenses and cause eye infections, especially when not replaced at recommended intervals (8). Sleeping in contact lenses was another commonly reported risk behavior. Although some soft and rigid contact

lenses have Food and Drug Administration approval for overnight wear, sleeping in any type of contact lens increases the risk for eye infections (9).

The findings in this report are subject to at least five limitations. First, respondents were part of a larger survey that was not specifically focused on contact lens behaviors. Therefore, participants might not have been representative of contact lens wearers in the United States. Second, adolescents were sampled through convenience sampling, specifically those living in the household of an adult taking the larger survey. This sampling method led to a small sample size of adolescent respondents. In addition, the number of young adults in the sample was small. Third, the sampling method differed from a sample in a previous report (4) that also asked risk behavior questions in a different manner (i.e., "ever" versus "regular" behaviors) and produced differences in the percentage of respondents reporting outcomes and behaviors. Fourth, because data were self-reported, respondents might have been reluctant to report risk behaviors because of social desirability bias. Finally, for the contact lens hygiene and outcomes questions, no period was stipulated; this might affect the comparison among age groups because the duration of contact lens use might differ and individual practices can change over time.

Although adolescent contact lens wearers reported engaging in some healthier contact lens hygiene behaviors than their adult counterparts, there is still room for improvement to prevent potentially serious outcomes, including blindness. Prevention efforts should focus on encouraging contact lens

Summary

What is already known about this topic?

In 2015, CDC established that there were approximately 41 million contact lens wearers aged ≥18 years in the United States, the majority of whom engaged in behaviors that put them at risk for serious eye infections.

What is added by this report?

In 2016, there were an estimated 3.6 million adolescents aged 12–17 years in the United States who wore contact lenses. Of the adolescents who wore contact lenses, 85% reported at least one behavior that put them at risk for a contact lens–related eye infection, compared with 81% of young adults, and 88% of older adults.

What are the implications for public health practice?

Although adolescent contact lens wearers engage in some healthier contact lens hygiene behaviors than do their adult counterparts, there is room for improvement in order to prevent potentially serious outcomes including blindness. Prevention efforts should focus on encouraging contact lens wearers to replace their contact lens storage case regularly and to avoid sleeping or napping in contact lenses.

wearers to replace their contact lens storage case regularly and to avoid sleeping or napping in contact lenses. There are insufficient data regarding the appropriate frequency of lens case and contact lens replacement, but contact lens wearers who do not follow recommended lens replacement schedules have more complications and self-reported discomfort than contact lens wearers who follow the replacement recommendations (6).[†]

Existing health communication strategies known to influence behavior change in adolescents (e.g., appeals to vanity and social norms marketing) can be applied to communication efforts focusing on contact lens hygiene behaviors in this population (10). Additionally, encouraging adolescents to adopt healthy contact lens wear and care habits early might help them maintain these habits into young adulthood, when the frequency of reported risk behaviors increases. Prevention messages targeting young adults can be shaped around the lifestyle changes known to occur in this population.

[†] https://www.cdc.gov/contactlenses/show-me-the-science.html.

Conflict of Interest

CDC receives an annual contribution from the Contact Lens Institute to support CDC's Healthy Contact Lens Program. The Contact Lens Institute had no involvement in the survey questions, analysis, drafting, or review of this manuscript.

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References

1. Stapleton F, Keay L, Jalbert I, Cole N. The epidemiology of contact lens related infiltrates. Optom Vis Sci 2007;84:257–72. https://doi.org/10.1097/OPX.0b013e3180485d5f
2. Wagner H, Richdale K, Mitchell GL, et al.; CLAY Study Group. Age, behavior, environment, and health factors in the soft contact lens risk survey. Optom Vis Sci 2014;91:252–61.
3. Chalmers RL, Wagner H, Mitchell GL, et al. Age and other risk factors for corneal infiltrative and inflammatory events in young soft contact lens wearers from the Contact Lens Assessment in Youth (CLAY) study. Invest Ophthalmol Vis Sci 2011;52:6690–6. https://doi.org/10.1167/iovs.10-7018
4. Cope JR, Collier SA, Rao MM, et al. Contact lens wearer demographics and risk behaviors for contact lens-related eye infections—United States, 2014. MMWR Morb Mortal Wkly Rep 2015;64:865–70. https://doi.org/10.15585/mmwr.mm6432a2
5. Stapleton F, Edwards K, Keay L, et al. Risk factors for moderate and severe microbial keratitis in daily wear contact lens users. Ophthalmology 2012;119:1516–21.https://doi.org/10.1016/j.ophtha.2012.01.052
6. Dumbleton KA, Woods CA, Jones LW, Fonn D. The relationship between compliance with lens replacement and contact lens-related problems in silicone hydrogel wearers. Cont Lens Anterior Eye 2011;34:216–22. https://doi.org/10.1016/j.clae.2011.03.001
7. Kilvington S, Powell CH, Lam A, Lonnen J. Antimicrobial efficacy of multi-purpose contact lens disinfectant solutions following evaporation. Cont Lens Anterior Eye 2011;34:183–7. https://doi.org/10.1016/j.clae.2011.02.010
8. Zimmerman AB, Richdale K, Mitchell GL, et al. Water exposure is a common risk behavior among soft and gas-permeable contact lens wearers. Cornea 2017;36:995–1001. https://doi.org/10.1097/ICO.0000000000001204
9. Dart JK, Radford CF, Minassian D, Verma S, Stapleton F. Risk factors for microbial keratitis with contemporary contact lenses: a case-control study. Ophthalmology 2008;115:1647–54. https://doi.org/10.1016/j.ophtha.2008.05.003
10. Farrelly MC, Duke JC, Nonnemaker J, et al. Association between The Real Cost media campaign and smoking initiation among youths—United States, 2014–2016. MMWR Morb Mortal Wkly Rep 2017;66:47–50. https://doi.org/10.15585/mmwr.mm6602a2

Hypertension Prevalence, Awareness, Treatment, and Control Among Adults Aged ≥18 Years — Los Angeles County, 1999–2006 and 2007–2014

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Hypertension is an important and common risk factor for heart disease and stroke, two of the leading causes of death in adults in the United States. Despite considerable improvement in increasing the awareness, treatment, and control of hypertension, undiagnosed and uncontrolled hypertension remain public health challenges (*1*). Data from the National Health and Nutrition Examination Survey (NHANES) were used to estimate the prevalence of hypertension, as well as awareness, treatment, and control of hypertension among adults aged ≥18 years in Los Angeles County compared with adults aged ≥18 years in the United States during 1999–2006 and 2007–2014. During 2007–2014, the prevalence of hypertension was 23.1% among adults in Los Angeles County, lower than the prevalence of 29.6% among all U.S. adults. Among adults with hypertension in Los Angeles County, substantial improvements from 1999–2006 to 2007–2014 were found in hypertension awareness (increase from 73.8% to 84.6%), treatment (61.3% to 77.2%), and control (28.5% to 48.3%). Similar improvements were also seen among all U.S. adults. Although the prevalence of hypertension among adults in Los Angeles County meets the Healthy People 2020 (https://www.healthypeople.gov/) goal of ≤26.9%, continued progress is needed to meet the Healthy People 2020 goal of ≥61.2% for control of hypertension.

NHANES is a cross-sectional survey designed to monitor the health and nutritional status of the civilian noninstitutionalized U.S. population, and is conducted continuously in 2-year cycles. The NHANES sample is based on a complex, multistage probability design that includes oversampling of particular population subgroups to obtain reliable estimates for these groups. During 1999–2006, Mexican Americans, and during 2007–2014, all Hispanics (including Mexican Americans) were among the subgroups oversampled. Because of the size and population density of Los Angeles County and the large Mexican American/Hispanic population, Los Angeles County is a primary sampling unit that was selected with certainty in each 2-year NHANES cycle and weights were calculated to match the population totals for Los Angeles County (*2,3*). Data were aggregated over 1999–2006 and 2007–2014 to provide adequate sample size for Los Angeles County. All prevalences were estimated using the examined sample, for which the overall NHANES response rate was 77.3% during 1999–2006 and 72.6% during 2007–2014.

NHANES includes interviews conducted in the participant's home and a standardized physical examination that includes measurement of blood pressure conducted in a mobile examination center.* Hypertension is defined as a mean systolic blood pressure of ≥140 mmHg, a mean diastolic blood pressure of ≥90 mmHg, or current use of medication to lower blood pressure (*4,5*). Awareness of and treatment for hypertension were self-reported.† Controlled hypertension was defined as having a mean systolic blood pressure <140 mmHg and a mean diastolic blood pressure <90 mmHg among persons with hypertension (*4,5*). Pregnant females were excluded from analyses (*4*). The Los Angeles County study sample included 975 adults during 1999–2006 and 1,084 adults during 2007–2014, and the U.S. sample included 19,989 adults during 1999–2006 and 23,647 adults during 2007–2014.

For all estimates, examination sample weights were used; analyses were performed using statistical software to account for the complex sample design. All reported prevalence estimates for adults aged ≥18 years were age-adjusted based on the 2000 U.S. Census projected population (*6*). All reported estimates of awareness, treatment, and control of hypertension for adults aged ≥18 years were age-adjusted using the subpopulation of persons who have hypertension in NHANES 2007–2008 (*4*). Standard errors of prevalences were estimated using Taylor series linearization and 95% confidence intervals were constructed using Korn and Graubard's method for use with small expected positive counts (*7*). Differences in prevalence of hypertension, awareness, treatment, and control by sex, age group, race, and Hispanic origin, and between the U.S. and Los Angeles County were evaluated by examining p-values calculated using a univariate two-sided t-statistic, with the combined standard error accounting for the correlation between Los Angeles County and the United States (*8*). All differences reported are statistically significant (p<0.05). No adjustments were made for multiple comparisons. Estimates with a relative standard error >30% were designated as potentially unreliable and should be interpreted with caution. Population counts were

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* NHANES examination methodology and analytic guidelines available at https://wwwn.cdc.gov/nchs/nhanes/Default.aspx.

† Awareness of hypertension was determined by an affirmative response to the question "Have you ever been told by a doctor or health professional that you had hypertension, also called high blood pressure?" Treatment for hypertension was defined based on affirmative responses to the following questions: "Because of your high blood pressure/hypertension, have you ever been told to take prescribed medicine?" and "Are you now following this advice to take prescribed medicine?"

calculated using the civilian noninstitutionalized population of Los Angeles County from the 2008–2012 5-year American Community Survey.

During 1999–2006, the age-adjusted prevalence of hypertension among adults was similar in Los Angeles County (28.0%) and the United States (29.6%); however, during 2007–2014, the age-adjusted prevalence of hypertension among adults was lower in Los Angeles County (23.1%, 1.7 million adults), compared with the United States (29.6%). Among adults with hypertension in Los Angeles County, from 1999–2006 to 2007–2014, awareness increased from 73.8% to 84.6%, treatment increased from 61.3% to 77.2%, and control of hypertension increased from 28.5% to 48.3%. During 2007–2014, in Los Angeles County, approximately 300,000 adults were unaware of their hypertension, approximately 400,000 were not being treated for hypertension, and approximately 800,000 did not have their hypertension controlled. Levels of awareness, treatment, and control of hypertension were similar in Los Angeles County and the United States during both 1999–2006 and 2007–2014 (Figure).

In both Los Angeles County and the United States, the prevalence of hypertension among adults increased with age, but younger age groups in Los Angeles County had significantly lower prevalences of hypertension compared with their

U.S. counterparts (3.0% compared with 7.5% and 22.5% compared with 32.5% in persons aged 18–39 years and 40–59 years, respectively) (Table). In Los Angeles County and the United States, non-Hispanic black adults had a significantly higher prevalence of hypertension compared with both Mexican American adults and non-Hispanic white adults. Non-Hispanic white adults and Mexican American adults in Los Angeles County had lower prevalences of hypertension than their counterparts in the United States (Table).

During 2007–2014, a higher percentage of adults aged 40–59 years with hypertension in Los Angeles County were aware of their hypertension (90.3%) than were adults of the same age in the United States (82.5%), whereas levels of awareness were similar among adults aged ≥60 years in Los Angeles County (87.8%) and the United States (85.9%). In Los Angeles County, 84.7%, 86.6%, and 91.1% of Mexican American, non-Hispanic black, and non-Hispanic white adults with hypertension, respectively, were aware of their hypertension, but these differences were not statistically significant.

Among adults with hypertension during 2007–2014, a higher percentage of women than men reported taking antihypertensive medication in Los Angeles County (83.3% versus 71.8%), but hypertension control was similar in women (48.0%) and men (47.0%). In Los Angeles County,

FIGURE. Age-adjusted prevalence* of hypertension,[†] and awareness, treatment, and control of hypertension[§] among adults aged ≥18 years — Los Angeles County and United States, 1999–2006 and 2007–2014
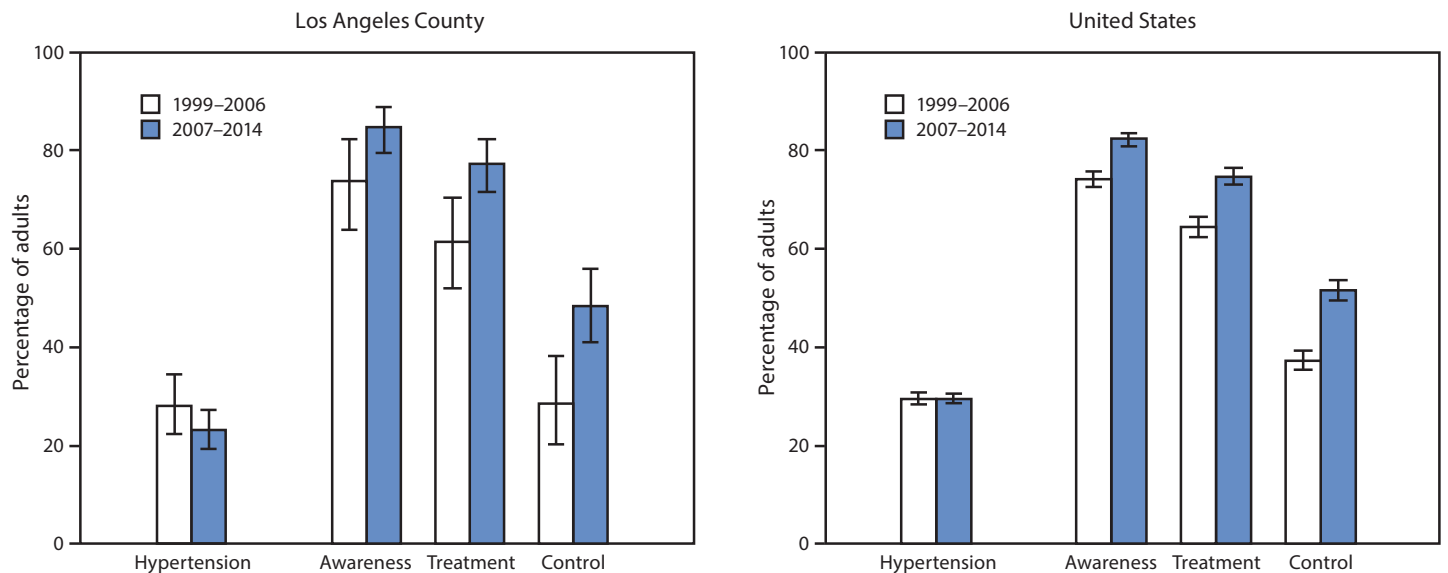
Source: National Center for Health Statistics, CDC: National Health and Nutrition Examination Survey (NHANES).
* Hypertension prevalence estimates were age-adjusted by the direct method to the 2000 U.S. Census population using the age groups 18–39, 40–59, and ≥60 years. Estimates for awareness, treatment, and control of hypertension were age-adjusted using the subpopulation of persons who have hypertension (age groups 18–39, 40–59, and ≥60 years) in NHANES 2007–2008.
[†] Statistically significant (p<0.05) difference in prevalence of hypertension between Los Angeles County and the United States in 2007–2014.
[§] Statistically significant (p<0.05) differences in awareness, treatment, and control of hypertension from 1999–2006 to 2007–2014 in both Los Angeles County and the United States.

TABLE. Age-adjusted prevalence of hypertension, and awareness, treatment, and control of hypertension* among adults aged ≥18 years, by sex, age, or race and Hispanic origin — Los Angeles County and United States, 2007–2014

		Sex		Age group (yrs)			Race and Hispanic origin		
							White, non-Hispanic	Black, non-Hispanic	Mexican American
Characteristic	Total	Male	Female	18–39	40–59	≥60			
Hypertension									
LA County	23.1 (19.1–27.3)[†]	20.9 (17.0–25.3)[†]	24.7 (19.0–31.1)	3.0 (1.4–5.6)[†,§]	22.6 (16.5–29.8)[†,¶]	61.6 (52.2–70.5)[¶,**]	17.3 (11.1–25.1)[†]	40.5 (30.6–50.9)[††]	22.9 (18.4–27.9)[†,§§]
United States	29.6 (28.7–30.5)	30.3 (29.2–31.5)	28.7 (27.6–29.9)[¶¶]	7.5 (6.8–8.2)	32.5 (30.9–34.1)[¶]	66.8 (64.9–68.5)[¶,**]	28.6 (27.5–29.8)	41.4 (39.7–43.0)[††]	26.8 (25.0–28.7)[††,§§]
Awareness									
LA County	84.6 (79.5–88.8)	81.4 (72.3–88.6)	87.8 (82.2–92.2)	—***	90.3 (81.7–95.7)[†]	87.8 (79.2–93.7)	91.1 (60.9–99.7)	86.6 (72.5–95.1)	84.7 (75.7–91.4)
United States	82.6 (81.2–83.9)	80.0 (78.2–81.7)	85.6 (84.1–87.1)[¶¶]	66.0 (60.2–71.4)	82.5 (79.9–84.8)[¶]	85.9 (84.4–87.3)[¶,**]	82.9 (81.0–84.7)	85.9 (84.1–87.6)[¶¶]	76.9 (74.0–79.7)[††,§§]
Treatment									
LA County	77.2 (71.4–82.3)	71.8 (62.2–80.1)	83.3 (77.1–88.4)[¶¶]	—***	81.0 (68.9–90.0)	83.8 (74.8–90.6)	87.0 (59.0–98.6)	77.5 (60.3–89.8)	70.6 (58.0–81.3)
United States	75.0 (73.2–76.7)	71.1 (69.1–73.0)	79.5 (77.5–81.4)[¶¶]	48.6 (43.3–54.0)	72.9 (69.7–75.8)[¶]	81.7 (80.2–83.2)[¶,**]	75.8 (73.5–78.0)	77.7 (75.3–79.8)	68.9 (65.4–72.3)[††,§§]
Control									
LA County	48.3 (40.9–55.8)	47.0 (38.1–56.0)	48.0 (36.8–59.4)	—***	56.2 (43.2–68.6)	48.6 (39.0–58.2)	48.1 (18.3–79.0)	56.3 (37.2–74.2)	47.2 (34.3–60.4)
United States	51.8 (49.6–53.9)	49.3 (46.8–51.8)	55.2 (52.8–57.6)[¶¶]	37.2 (31.9–42.6)	55.0 (51.4–58.6)[¶]	52.0 (49.9–54.2)[¶]	54.5 (51.8–57.3)	47.2 (44.6–49.8)[††]	42.7 (38.7–46.7)[††,§§]

Source: National Center for Health Statistics, CDC: National Health and Nutrition Examination Survey (NHANES).
Abbreviations: CI = confidence interval; LA = Los Angeles.
* Hypertension prevalence estimates were age-adjusted by the direct method to the 2000 U.S. Census population using the age groups 18–39, 40–59, and ≥60 years. Estimates for awareness, treatment, and control of hypertension were age-adjusted using the subpopulation of persons who have hypertension (age groups 18–39, 40–59, and ≥60 years) in NHANES 2007–2008.
[†] Significantly different from the United States.
[§] Estimate might be unreliable because relative standard error >30%.
[¶] Significantly different from age group 18–39 years.
[**] Significantly different from age group 40–59 years.
[††] Significantly different from non-Hispanic white adults.
[§§] Significantly different from non-Hispanic black adults.
[¶¶] Significantly different from men.
[***] Statistical reliability criteria not met because sample size (n = 17) was less than the required minimum.

treatment and control of hypertension were similar in adults aged 40–59 years and ≥60 years.

In Los Angeles County during 2007–2014, treatment and control of hypertension among non-Hispanic white adults were 87.0% and 48.1%, respectively, 70.6% and 47.2% among Mexican American adults, and 77.5% and 56.3% among non-Hispanic black adults. However, the observed differences in treatment and control of hypertension by race and Hispanic origin were not statistically significant.

Discussion

Los Angeles County has been included in every 2-year NHANES cycle; therefore, the prevalence of many health conditions can be estimated and compared with those in the U.S. population. The examination component of NHANES allows estimation of the prevalence of both diagnosed and undiagnosed hypertension, as well as awareness, treatment, and control of hypertension. During 2007–2014 the age-adjusted prevalence of hypertension among adults was significantly lower in Los Angeles County (23.1%) than in the United States (29.6%), and improvements were made in awareness, treatment, and control of hypertension from 1999–2006 to 2007–2014. However, during 2007–2014, a total of 1.7 million adults aged ≥18 years in Los Angeles County were estimated to have hypertension, including approximately 300,000 who were unaware of their hypertension, approximately

400,000 who were not being treated for hypertension, and approximately 800,000 whose hypertension was not controlled. Emerging federal, state, and local initiatives to identify and control undiagnosed or undertreated hypertension in the community currently focus on investments in team care, which include the use of nonphysician extenders such as community health workers, home self-measured blood pressure monitoring, and comprehensive medication management programs led by pharmacists.[§] Recent measures have also included strategies to reduce excess sodium consumption, as recommended by the Million Hearts initiative (https://millionhearts.hhs.gov) (9).

The findings in this report are subject to at least two limitations. First, the smaller Los Angeles County sample size required aggregation over an 8-year time period to produce reliable estimates. Second, because of the low prevalence of hypertension in persons aged 18–39 years, awareness, treatment, and control of hypertension could not be estimated and statistical tests could not be performed for this age group in Los Angeles County. The smaller effective sample size also reduced the power to detect differences by age and race or Hispanic origin in Los Angeles County.

Although progress has been made in the diagnosis, treatment, and control of hypertension in Los Angeles County, the

[§] CDC State and Local Public Health Actions to Prevent Obesity, Diabetes, and Heart Disease and Stroke: Fact Sheet and Community Profiles. http://healthyamericans.org/health-issues/wp-content/uploads/2016/09/1422.pdf.

Summary

What is already known about this topic?

Approximately one third of U.S. adults have hypertension, and only about half of these adults have their hypertension under control. Hypertension is an important and common risk factor for heart disease and stroke, two of the leading causes of death in adults.

What is added by this report?

The examination component of National Health and Nutrition Examination Survey (NHANES) allows estimation of the prevalence of both diagnosed and undiagnosed hypertension, as well as awareness, treatment, and control of hypertension in Los Angeles County. During 2007–2014 the age-adjusted prevalence of hypertension among adults was significantly lower in Los Angeles County (23.1%) than in the United States (29.6%). Among adults with hypertension in Los Angeles County, awareness, treatment, and control improved significantly from 1999–2006 to 2007–2014; however, more than half of these adults still did not have their hypertension under control.

What are the implications for public health practice?

NHANES will continue to be an important source of data for monitoring progress in hypertension prevalence, awareness, treatment, and control, as evidence-based practices, such as those promoted through the Million Hearts initiative, continue to be implemented in Los Angeles County.

Healthy People 2020 goal for control of hypertension has not been met. NHANES will continue to be an important source of data for monitoring progress in hypertension prevalence, awareness, treatment, and control, as evidence-based practices, such as those promoted through the Million Hearts initiative, continue to be implemented in Los Angeles County (10).

Conflict of Interest

No conflicts of interest were reported.

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References

1. Mozaffarian D, Benjamin EJ, Go AS, et al.; Writing Group Members; American Heart Association Statistics Committee; Stroke Statistics Subcommittee. Heart disease and stroke statistics—2016 update: a report from the American Heart Association. Circulation 2016;133:e38–360. https://doi.org/10.1161/CIR.0000000000000350
2. Parker J, Kruszon-Moran D, Mohadjer LK, et al. Estimation methods and analytic considerations: California and Los Angeles County, NHANES 1999–2006 and NHANES 2007–2014. In: National Center for Health Statistics, ed. Vital Health Statistics; 2017. https://stacks.cdc.gov/view/cdc/46009
3. Porter KS, Curtin LR, Carroll MD, et al. Health of adults in Los Angeles County: findings from the National Health and Nutrition Examination Survey, 1999–2004. National health statistics report, no. 42; 2011. Hyattsville, MD: US Department of Health and Human Services, CDC, National Center for Health Statistics; 2011. https://www.cdc.gov/nchs/data/nhsr/nhsr042.pdf
4. Crim MT, Yoon SS, Ortiz E, et al. National surveillance definitions for hypertension prevalence and control among adults. Circ Cardiovasc Qual Outcomes 2012;5:343–51. https://doi.org/10.1161/CIRCOUTCOMES.111.963439
5. Chobanian AV, Bakris GL, Black HR, et al.; National High Blood Pressure Education Program Coordinating Committee. The seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. JAMA 2003;289:2560–72. https://doi.org/10.1001/jama.289.19.2560
6. Klein RJ, Schoenborn CA. Age adjustment using the 2000 projected U.S. population. Healthy people 2010 statistical notes, no. 20. Atlanta, GA: US Department of Health and Human Services, CDC, National Center for Health Statistics; 2001. https://www.cdc.gov/nchs/data/statnt/statnt20.pdf
7. Korn EL, Graubard BI. Confidence intervals for proportions with small expected number of positive counts estimated from survey data. Surv Methodol 1998;24:193–201.
8. Kish L. Special selection techniques. Survey sampling. New York, New York: John Wiley & Sons, Inc.; 1995.
9. Mugavero KL, Gunn JP, Dunet DO, Bowman BA. Sodium reduction: an important public health strategy for heart health. J Public Health Manag Pract 2014;20(Suppl 1):S1–5. https://doi.org/10.1097/PHH.0b013e3182aa659c
10. Jaffe MG, Lee GA, Young JD, Sidney S, Go AS. Improved blood pressure control associated with a large-scale hypertension program. JAMA 2013;310:699–705. https://doi.org/10.1001/jama.2013.108769

Occupational Distribution of Campylobacteriosis and Salmonellosis Cases — Maryland, Ohio, and Virginia, 2014

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Campylobacter and *Salmonella* are leading causes of bacterial gastroenteritis in the United States and are estimated to cause >1 million episodes of domestically acquired illness annually (*1*). *Campylobacter* and *Salmonella* are primarily transmitted through contaminated food, but animal-to-human and human-to-human transmission can also occur (*2,3*). Although occupationally acquired infections have been reported, occupational risk factors have rarely been studied. In 2015, the Occupational Safety and Health Administration (OSHA) identified 63 suspected or confirmed cases of *Campylobacter* infection over 3.5 years at a poultry-processing plant (Kathleen Fagan, OSHA, personal communication, December 2015); most involved new workers handling chickens in the "live hang" area where bacterial contamination is likely to be the highest. These findings were similar to those of a previous study of *Campylobacter* infections among workers at another poultry-processing plant (*4*). The investigation led to discussions among OSHA, state health departments, and CDC's National Institute for Occupational Safety and Health (NIOSH); and a surveillance study was initiated to further explore the disease incidence in poultry-processing plant workers and identify any additional occupations at increased risk for common enteric infections. Deidentified reports of campylobacteriosis and salmonellosis among Maryland, Ohio, and Virginia residents aged ≥16 years were obtained and reviewed. Each employed patient was classified into one of 23 major occupational groups using the 2010 Standard Occupational Classification (SOC) system.* Risk ratios (RR) and 95% confidence intervals (CI) for associations between each occupational group and each disease were calculated to identify occupations potentially at increased risk, contrasting each group with all other occupations. In 2014, a total of 2,977 campylobacteriosis and 2,259 salmonellosis cases were reported. Among the 1,772 (60%) campylobacteriosis and 1,516 (67%) salmonellosis cases in patients for whom occupational information was available, 1,064 (60%) and 847 (56%), respectively, were employed. Persons in farming, fishing, and forestry as well as health care and technical occupations were at significantly increased risk for both campylobacteriosis and salmonellosis compared with all other occupations. Targeting education and prevention strategies could help reduce disease, and improving the systematic collection of occupational information in disease surveillance systems could provide a better understanding of the extent of occupationally acquired diseases.

For this analysis, deidentified reports of confirmed, probable, and suspected campylobacteriosis and salmonellosis[†] cases reported during 2014 in residents aged ≥16 years were obtained from notifiable diseases surveillance systems in Maryland, Ohio, and Virginia. These states were invited to join in this study because occupation was recorded in a free text field in each case report in these states. In Ohio and Virginia, the reports also noted whether the patient was a health care worker, food handler, or daycare worker. Patients were assigned to one of three categories: employed, not employed (e.g., retired, student, homemaker, or unemployed at the time of disease reporting), or unknown. A standard two-digit 2010 SOC code was manually assigned to each case in an employed person. Where necessary, the NIOSH Industry and Occupation Computerized Coding System[§] was used to assist in translating occupation text into standardized codes. Cases in persons in the military and those with occupations that could not be assigned a code because of insufficient information were excluded.

The 2014 American Community Survey (ACS)[¶] was used to estimate the employed civilian population in the three included states combined. ACS, an ongoing survey, provides vital information about the U.S. population by state each year. RRs for each disease among each occupational group were calculated by comparing the risk for infection in each occupational group with risk among all other employed persons; 95% CIs were estimated based on a Poisson distribution using statistical software to conduct the analyses.

In 2014, a total of 2,977 campylobacteriosis and 2,259 salmonellosis cases were reported in persons aged ≥16 years in Maryland, Ohio, and Virginia. Information about occupation was available for 1,772 (60%) campylobacteriosis cases and 1,516 (67%) salmonellosis cases. Among these, 1,064 (60%) campylobacteriosis patients and 845 (56%) salmonellosis patients were employed, and 708 (40%) and 669 (44%), respectively, were not employed (Figure). The 2014 ACS data for these three states combined indicated that 61% of persons aged ≥16 years were employed and 39% were not employed.
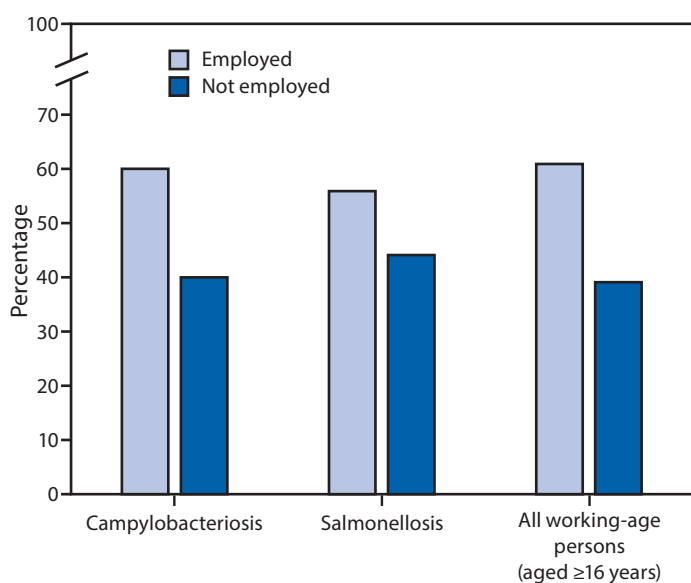
Among all cases in employed persons, nearly 72% of campylobacteriosis and 97% of salmonellosis cases were confirmed

FIGURE. Percentages of campylobacteriosis and salmonellosis cases, and of all persons aged ≥16 years, by employment status — notifiable disease surveillance systems and American Community Survey, Maryland, Ohio, and Virginia, 2014

TABLE 1. Characteristics of employed persons with campylobacteriosis (N = 1,064) and salmonellosis (N = 847) — notifiable diseases surveillance systems, Maryland, Ohio, and Virginia, 2014

Characteristic	No. (%)	
	Campylobacteriosis	Salmonellosis
Case classification		
Confirmed	761 (71.5)	822 (97.0)
Suspected	286 (26.9)	7 (0.8)
Probable	17 (1.6)	18 (2.1)
Sex		
Male	592 (55.6)	362 (42.7)
Female	472 (44.4)	485 (57.3)
Age group (yrs)		
16–24	119 (11.2)	133 (15.7)
25–44	409 (38.4)	369 (43.6)
45–64	450 (42.3)	284 (33.5)
≥65	83 (7.8)	59 (7.0)
Unknown	3 (0.3)	2 (0.2)
Race/Ethnicity		
White, non-Hispanic	766 (72.0)	608 (71.8)
Black, non-Hispanic	78 (7.3)	90 (10.6)
Hispanic/Latino	35 (3.3)	25 (3.0)
Asian, non-Hispanic	23 (2.2)	12 (1.4)
Other, non-Hispanic	4(0.4)	7 (0.8)
Unknown	158 (14.8)	105 (12.4)

(Table 1). Compared with persons in other occupations, workers in farming, fishing, and forestry occupations and health care and technical occupations, were at significantly increased risk for campylobacteriosis (RR = 10.0 and 1.5, respectively) and salmonellosis (RR = 3.2 and 2.0) (Table 2). These two occupational groups accounted for 3.1% and 9.2% of campylobacteriosis cases and 1.0% and 11.5% of salmonellosis cases, respectively (Table 2). Workers in the broad category of production occupations were at increased risk for campylobacteriosis (RR = 1.4). A higher risk for salmonellosis was observed in workers in the food preparation and serving–related occupations (RR = 1.6) and personal care and service occupations (RR = 1.5). Among 41 campylobacteriosis cases among poultry-processing plant workers, cases occurred in three occupation categories: 38 in production, one in management, and two in building cleaning.

Discussion

This report describes the occupational distribution of campylobacteriosis and salmonellosis cases in three states during 2014. Persons in farming, fishing, and forestry occupations and health care and technical occupations were at increased risk for both campylobacteriosis and salmonellosis. The food preparation and serving–related occupations and personal care and service occupations were also at higher risk for salmonellosis. Although *Campylobacter* and *Salmonella* infections are typically considered foodborne, both have other potential sources such as ill patients, animals, and the environment. The

incidence of foodborne illnesses, including those attributable to *Campylobacter* and *Salmonella*, has changed little despite recent improvements in food safety (*1*). Targeting of education and prevention strategies (e.g., disease awareness and proper hand hygiene techniques at work) toward specific groups at high risk and their employers could help reduce the incidence.

A recent systematic literature review found that certain occupational groups, including health care workers and workers with animal contact, are at increased risk for exposure to work-related infectious diseases (*3*). Therefore, occupational information could be important in identifying groups at increased risk for enteric infections. In addition, occupational information could be used to examine the contribution of work-related environmental hazards, including infectious pathogens, to explain different risks for health outcomes in the United States (*5*). Nevertheless, the occupational information in current infectious disease surveillance systems is inadequate and has rarely been analyzed systematically to describe patterns of disease by occupation.

The finding that agriculture workers are at higher risk for infection is not surprising because of the opportunities for exposure and potential for disease transmission in the workplace. An estimated 17% of campylobacteriosis and 11% of salmonellosis cases are attributable to animal contact (*6*), and contact with farm animals previously has been identified as a risk factor for sporadic *Campylobacter* infection in the United States (*7*). The current analysis also showed campylobacteriosis cases among workers with different duties in multiple

TABLE 2. Distribution of all employed persons, campylobacteriosis* and salmonellosis cases,[†] and calculation of relative risk for disease based upon occupational distributions,[§] by occupational category — notifiable disease surveillance systems and American Community Survey, Maryland, Ohio, and Virginia, 2014

Occupation category	All employed %	Campylobacteriosis No. (%)	Campylobacteriosis RR[¶] (95% CI)	Salmonellosis No. (%)	Salmonellosis RR[¶] (95% CI)
Management**	10.8	83 (8.5)	0.8 (0.6–1.0)	73 (9.2)	0.8 (0.7–1.1)
Business and financial operations	5.4	51 (5.2)	1.0 (0.7–1.3)	34 (4.3)	0.8 (0.6–1.1)
Computer and mathematical	3.9	42 (4.3)	1.1 (0.8–1.5)	26 (3.3)	0.8 (0.6–1.2)
Architecture and engineering	1.9	19 (2.0)	1.0 (0.6–1.6)	11 (1.4)	0.7 (0.4–1.3)
Life, physical, and social science	1.1	12 (1.2)	1.1 (0.6–1.9)	7 (0.9)	0.8 (0.4–1.6)
Community and social services	1.7	22 (2.3)	1.3 (0.9–2.0)	13 (1.6)	1.0 (0.6–1.7)
Legal	1.3	13 (1.3)	1.0 (0.6–1.8)	10 (1.3)	1.0 (0.5–1.8)
Education, training, and library	6.1	52 (5.3)	0.9 (0.7–1.2)	39 (4.9)	0.8 (0.6–1.1)
Arts, design, entertainment, sports, and media	1.9	20 (2.1)	1.1 (0.7–1.7)	12 (1.5)	0.8 (0.5–1.4)
Healthcare practitioners and technical[††]	6.2	90 (9.2)	1.5 (1.2–1.9)	92 (11.5)	2.0 (1.6–2.5)
Healthcare support	2.3	20 (2.1)	0.9 (0.6–1.4)	26 (3.3)	1.4 (1.0–2.1)
Protective service	2.4	24 (2.5)	1.0 (0.7–1.5)	23 (2.9)	1.2 (0.8–1.8)
Food preparation and serving related[††]	5.6	58 (6.0)	1.1 (0.8–1.4)	68 (8.5)	1.6 (1.2–2.0)
Building and grounds cleaning and maintenance[§§]	3.6	37 (3.8)	1.1 (0.8–1.5)	30 (3.8)	1.1 (0.7–1.5)
Personal care and service[††]	3.2	36 (3.7)	1.1 (0.8–1.6)	39 (4.9)	1.5 (1.1–2.1)
Sales and related	9.8	93 (9.6)	1.0 (0.8–1.2)	63 (7.9)	0.8 (0.6–1.0)
Office and administrative support	12.8	103 (10.6)	0.8 (0.7–1.0)	96 (12.0)	0.9 (0.8–1.2)
Farming, fishing, and forestry[††]	0.3	30 (3.1)	10.0 (7.0–14.4)	8 (1.0)	3.2 (1.6–6.4)
Construction and extraction	4.6	28 (2.9)	0.6 (0.4–0.9)	30 (3.8)	0.8 (0.6–1.2)
Installation, maintenance, and repair	3.1	29 (3.0)	1.0 (0.7–1.4)	17 (2.1)	0.7 (0.4–1.1)
Production[††,¶¶]	5.8	79 (8.1)	1.4 (1.1–1.8)	42 (5.3)	0.9 (0.7–1.2)
Transportation and material moving	6.2	32 (3.3)	0.5 (0.4–0.7)	37 (4.6)	0.7 (0.5–1.0)
Total	**100.0**	**973 (100.0)**	—	**796 (100.0)**	—

Abbreviations: CI = confidence interval; RR = relative risk.
 * Excludes 75 employed persons with unclassified occupation and 16 in active military service.
 [†] Excludes 40 employed persons with unclassified occupation and 11 in active military service.
 [§] Calculated using data from the American Community Survey.
 [¶] Risk for infection in each occupation divided by that among all other employed persons.
 ** Includes 13 self-employed farmers or farm owners with campylobacteriosis and six with salmonellosis; one poultry-processing plant manager with campylobacteriosis.
 [††] Occupation categories for which the 95% CI for the RR for one or both diseases does not include 1.0.
 [§§] Includes two sanitation workers in poultry-processing plants with campylobacteriosis and one with salmonellosis.
 [¶¶] Includes 38 poultry-processing plant workers with campylobacteriosis and three with salmonellosis.

poultry-processing facilities, supporting the previous finding that poultry workers are at elevated risk for *Campylobacter* exposure because of heavy workplace contamination (*8*).

Health care workers, personal care and service workers, and food preparation workers were also found to be at increased risk for infection. *Campylobacter* and *Salmonella* can also be transmitted from person to person by the fecal-oral route. Therefore, health care workers might be exposed to these pathogens through contact with patients, which indicates a potential occupational risk. Occupational transmission of *Salmonella* to health care workers has been previously identified (*3*). Occupationally acquired *Campylobacter* infections among health care workers are also possible, but have not been described. The personal care and service occupations category includes certain occupations involving close contact with patients in long-term care facilities and children in child care settings. Persons who care for nontoilet-trained children are known to be at risk for contact with enteric pathogens (*9*). Additionally, workers in food preparation and serving-related occupations might be at increased risk for salmonellosis from handling contaminated meat or foods and are known to be

sources of transmission in outbreaks (*10*). Because of the risk for spread of the disease to customers or clients, all cases of campylobacteriosis and salmonellosis among workers should be reported and reviewed to identify the source and prevent ongoing transmission.

The findings in this report are subject to at least three limitations. First, employment in an occupation at high risk for infection does not prove causation; other possible exposure sources were not evaluated. Risk factors among specific workers must be studied to better characterize the risk for occupationally acquired diseases. Second, occupational information was missing for multiple cases and data might not be missing at random. Cases in the three job categories with specific fields on case report forms (i.e., health care worker, food handler, or daycare worker) might have been more likely to be recorded. Finally, despite a combination of manual and computer-assisted occupation coding processes, misclassification might have occurred because of incomplete descriptions and the absence of a field for industry on the case reports. In general, the term "industry" refers to the type of business for which a person works (e.g., poultry-processing plant), and the term "occupation" refers to a worker's specific job (e.g.,

Summary

What is already known about this topic?

Campylobacter and *Salmonella* are leading causes of bacterial gastroenteritis in the United States with >1 million cases reported annually. These pathogens are primarily transmitted through consumption of contaminated food, but animal-to-human and human-to-human transmission also occur. Occupational transmission has been reported, but there is limited information regarding patterns of disease by occupation.

What is added by this report?

In 2014, 2,977 campylobacteriosis and 2,259 salmonellosis cases were reported in Maryland, Ohio, and Virginia; 1,064 (60%) and 847 (56%) patients, respectively, were employed. Persons in farming, fishing, and forestry occupations and health care and technical occupations were at increased risk for both campylo-bacteriosis and salmonellosis. Persons in food preparation and serving–related occupations and personal care and service occupations were also at higher risk for salmonellosis.

What are the implications for public health practice?

Increased risk for enteric infection among workers in agriculture, health care, food, and personal care occupations might be related to workplace exposures to pathogens. Campylobacteriosis or salmonellosis should be considered when workers have symptoms compatible with these diseases. Targeting education and prevention strategies, including disease awareness and proper hygiene techniques at work, to groups at higher risk and their employers could help reduce disease.

plant manager). The collection of both industry and occupation information can help public health workers identify potential risk factors in need of further assessment.

Campylobacteriosis or salmonellosis should be considered when workers in occupations at increased risk for infection have symptoms compatible with these diseases. Discovering underlying mechanisms of transmission and assessing hazards in the workplace could help employers plan disease prevention measures, such as providing personal protective equipment and hand hygiene education. To improve data collection in surveillance systems, occupational questions should be stan-dardized, information on both industry and occupation should be collected, and data should be analyzed with standard cod-ing schemes to monitor disease trends in specific industries or occupations and protect workers' health.

Conflict of Interest

No conflicts of interest were reported.

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References

1. Scallan E, Hoekstra RM, Angulo FJ, et al. Foodborne illness acquired in the United States—major pathogens. Emerg Infect Dis 2011;17:7–15. https://doi.org/10.3201/eid1701.P11101
2. Haagsma JA, Tariq L, Heederik DJ, Havelaar AH. Infectious disease risks associated with occupational exposure: a systematic review of the literature. Occup Environ Med 2012;69:140–6. https://doi.org/10.1136/oemed-2011-100068
3. Sepkowitz KA. Occupationally acquired infections in health care workers. Part II. Ann Intern Med 1996;125:917–28. https://doi.org/10.7326/0003-4819-125-11-199612010-00008
4. de Perio MA, Niemeier RT, Levine SJ, Gruszynski K, Gibbins JD. *Campylobacter* infection in poultry-processing workers, Virginia, USA, 2008–2011. Emerg Infect Dis 2013;19:286–8. https://doi.org/10.3201/eid1902.121147
5. MacDonald LA, Cohen A, Baron S, Burchfiel CM. Occupation as socioeconomic status or environmental exposure? A survey of practice among population-based cardiovascular studies in the United States. Am J Epidemiol 2009;169:1411–21. https://doi.org/10.1093/aje/kwp082
6. Hale CR, Scallan E, Cronquist AB, et al. Estimates of enteric illness attributable to contact with animals and their environments in the United States. Clin Infect Dis 2012;54(Suppl 5):S472–9. https://doi.org/10.1093/cid/cis051
7. Friedman CR, Hoekstra RM, Samuel M, et al.; Emerging Infections Program FoodNet Working Group. Risk factors for sporadic *Campylobacter* infection in the United States: a case-control study in FoodNet sites. Clin Infect Dis 2004;38(Suppl 3):S285–96. https://doi.org/10.1086/381598
8. Price LB, Roess A, Graham JP, et al. Neurologic symptoms and neuropathologic antibodies in poultry workers exposed to *Campylobacter jejuni*. J Occup Environ Med 2007;49:748–55. https://doi.org/10.1097/JOM.0b013e3180d09ec5
9. Bright KA, Calabro K. Child care workers and workplace hazards in the United States: overview of research and implications for occupational health professionals. Occup Med (Lond) 1999;49:427–37. https://doi.org/10.1093/occmed/49.7.427
10. Medus C, Smith KE, Bender JB, Besser JM, Hedberg CW. *Salmonella* outbreaks in restaurants in Minnesota, 1995 through 2003: evaluation of the role of infected foodworkers. J Food Prot 2006;69:1870–8. https://doi.org/10.4315/0362-028X-69.8.1870

Progress Toward Poliomyelitis Eradication — Afghanistan, January 2016–June 2017

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Afghanistan, Pakistan, and Nigeria remain the only countries where the transmission of endemic wild poliovirus type 1 (WPV1) continues (1). This report describes polio eradication activities, progress, and challenges in Afghanistan during January 2016–June 2017 and updates previous reports (2,3). Thirteen WPV1 cases were confirmed in Afghanistan in 2016, a decrease of seven from the 20 cases reported in 2015. From January to June 2017, five WPV1 cases were reported, compared with six during the same period in 2016. The number of affected districts declined from 23 (including WPV1-positive acute flaccid paralysis [AFP] cases and positive environmental sewage samples) in 2015 to six in 2016. To achieve WPV1 eradication, it is important that Afghanistan's polio program continue to collaborate with that of neighboring Pakistan to track and vaccinate groups of high-risk mobile populations and strengthen efforts to reach children in security-compromised areas.

Immunization Activities

Estimated routine immunization coverage of infants with 3 doses of oral poliovirus vaccine (OPV3) in Afghanistan was 60% in both 2015 and 2016 (4). The percentage of children aged 6–23 months with nonpolio acute flaccid paralysis (NPAFP) who received 3 doses of OPV through routine immunization programs is used as a proxy indicator for OPV3 coverage nationally and was 65% in 2015 and 67% in 2016. However, there was wide regional variation, ranging from 100% in the Central provinces to 28% in the Southern province of Helmand. The proportion of children aged 6–23 months with NPAFP who had never received OPV through routine immunization or supplementary immunization activities (SIAs)* (i.e., "zero-dose" children) was approximately 1% nationally in 2016, virtually unchanged from 2015. The highest percentages of zero-dose children were reported from four provinces in 2016: Paktika (17%), Badghis (7%), Helmand (6%), and Nangarhar (2%).

During January 2016–May 2017, SIAs targeted children aged <5 years for receipt of one or both of the following vaccines: bivalent OPV (types 1 and 3) or trivalent OPV (types 1, 2, and 3 [until the global withdrawal of all type 2-containing OPVs, including tOPV, on May 1, 2016]). In addition, inactivated

polio vaccine (IPV) was administered during SIAs to children aged 4–59 months who had not received IPV during a previous campaign and who lived in the 47 districts designated to be at very high risk for poliovirus transmission or in areas that had been inaccessible for three or more previous SIAs. During this period, 15 SIAs were conducted using OPV with or without IPV, including six national immunization days (NIDs) and nine subnational immunization days (sNIDs). Five case-response vaccination campaigns (i.e., mop-up campaigns) and five short-interval additional dose rounds (SIADs)[†] were also held.

Vaccination of children aged <10 years continued at border crossing points with Pakistan and throughout the country along major travel routes and at the entry and exit points to and from inaccessible areas. Teams of vaccinators at these locations reached approximately 11 million children with OPV in 2016 and approximately 5 million during January–May 2017.

Insecurity associated with active conflicts limits the program's ability to reach all children with polio vaccine during SIAs. The polio program addresses issues of access by deferring the campaign in areas with active fighting, and by engaging in dialogue with local influencers, which, to date, has demonstrated limited success in gaining access for vaccination activities.

During the March 2016 NIDs, among 9,523,420 children aged <5 years targeted for vaccination, 184,363 children (1.9%) were missed because of inaccessibility, including 11,684 (0.1%) in the Southern provinces of Helmand, Kandahar, and Uruzgan; 25,869 (0.3%) in the Eastern provinces of Kunar, Nangarhar, and Nuristan; and 146,810 (1.5%) in the Northeastern province of Kunduz. During the October 2016 NIDs, the number of inaccessible children increased to 393,737, representing 4.4% of those targeted. The number of inaccessible children was reduced during the March 2017 NIDs to 98,915 (1%) and further to 80,899 during the May 2017 NIDs. The reductions are reflective of the recent progress in the Kunduz province in Northeast, where, after nearly 1.5 years of campaign bans, full access was obtained.

Despite the challenges of inaccessibility, the largest numbers of children missed during campaigns live in accessible areas of Afghanistan. Postcampaign evaluation surveys reveal

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* Mass vaccination campaigns that aim to administer additional doses of OPV to each child aged <5 years, regardless of vaccination history.

† Short-interval, additional dose campaigns are used for case-response vaccination after detection of a WPV case or during negotiated periods of nonviolence in otherwise inaccessible areas, to provide 2 doses of monovalent or bivalent OPV within 1–2 weeks.

that children are missed in these areas because of reasons that include the child was not at home; vaccine was refused; or the child was sick, sleeping, or a newborn. The percentages of children missed during campaigns in accessible areas ranged from 5.7% in the March 2016 NID to 4.1% in the March 2017 NID. The Southern part of the country continues to record the largest percentages of children in accessible areas missed, with 9.5% missed in March 2016 and 5.8% in March 2017.

Lot Quality Assurance Sampling§ surveys are used to assess the quality of SIAs. Campaigns in 2016 showed a nearly consistent monthly reduction in the number of failed lots (rejected at 80% threshold) from 25% rejected in the March 2016 NID down to 9% in the May 2017 NID, indicating an improvement in SIA quality.

Poliovirus Surveillance

AFP surveillance. Afghanistan has an extensive AFP surveillance network including reporting sites at government and private health facilities, shrines, and by traditional healers. This network is supplemented by an extensive network of reporting volunteers that has increased 66%, from 17,218 in 2015 to 28,543 in 2017. In 2016, the annual national NPAFP rate was 14.4 per 100,000 children aged <15 years (range = 9.8–20.4 per 100,000; surveillance target = 2/100,000 children aged <15 years) (Table). The percentage of AFP cases with adequate stool specimens¶ collected was 92.2% (range = 85.2%–98.2%; target = 80%). No polio-compatible AFP cases were reported during the period covered by this report. Analysis of surveillance data shows comparable sensitivity across different access categories. The NPAFP rate exceeded 10 per 100,000 children aged <15 years, and the percentage of AFP cases with adequate stool specimens exceeded 85% across areas with varying levels of inaccessibility related to security challenges.

Environmental surveillance. Since September 2013, Afghanistan has been conducting supplemental poliovirus surveillance through sampling of sewage at designated sites. There are currently 17 active sites in six provinces throughout the country (Helmand and Kandahar in the Southern region, Kunar and Nangarhar in the Eastern region, Kabul in the

§ Lot Quality Assurance Sampling is a rapid survey method used to assess the quality of vaccination activities after SIAs in predefined areas, such as health districts (referred to as "lots"), using a small sample size. Lot quality assurance sampling involves dividing the population into "lots" and randomly selecting persons in each lot. If the number of unvaccinated persons in the sample exceeds a predetermined value, then the lot is classified as having an unsatisfactory level of vaccination coverage, and mop-up activities are recommended. If the threshold of ≥80% is met, the area/district is classified as having "passed," although mop-up activities might still be indicated in certain areas.

¶ The indicator for stool adequacy requires that at least 80% of AFP cases should have "adequate" stool specimens collected. "Adequate" stool specimens are defined as two stool specimens of sufficient quantity for laboratory analysis, collected at least 24 hours apart, within 14 days after the onset of paralysis, and arriving in the laboratory by reverse cold chain and with proper documentation.

TABLE. Acute flaccid paralysis (AFP) surveillance indicators and reported cases of wild poliovirus (WPV), by region and period — Afghanistan, January 2016–June 2017*

Region of Afghanistan	AFP surveillance indicators (2016)			No. WPV cases reported		
	No. AFP cases	Rate of nonpolio AFP†	% of AFP cases with adequate specimens§	January–June 2016	July–December 2016	January–June 2017
All regions	**2,891**	**14.4**	**92.2**	**6**	**7**	**5**
Badakhshan	56	9.8	98.2	0	0	0
Northeastern	285	12.6	92.2	0	0	1
Northern	319	12.7	90.9	0	0	0
Central	507	11	96.4	0	0	0
Eastern	405	20.4	95.4	4	0	0
Southeastern	261	13.2	91.4	0	7	0
Southern	588	16.7	85.2	2	0	4
Western	470	17.6	94.0	0	0	0

* Data current through June 30, 2017.
† Per 100,000 children aged <15 years. Surveillance target is 2/100,000 children aged <15 years.
§ Surveillance target is that at least 80% of AFP cases have "adequate" stool specimens collected. "Adequate" stool specimens are defined as two stool specimens of sufficient quality for laboratory analysis, collected ≥24 hours apart, both within 14 days of paralysis onset, and arriving to a World Health Organization–accredited laboratory by reverse cold chain and with proper documentation.

Central region, and Khost in the Southeastern region). Three of these sites were added in 2016 (Kandahar and Nangarhar) and 2017 (Khost). During this time, sampling frequency also increased from monthly to biweekly in the Southern region. In 2015, among 148 specimens, 19 (6%) tested positive for WPV1. In 2016, only two (1%) of 184 specimens tested positive for WPV1. As of June 2017, seven (5%) of 150 specimens have tested positive for WPV1. The seven positive samples were collected at sites in Nangarhar (three specimens), Kandahar (three), and Helmand (one).
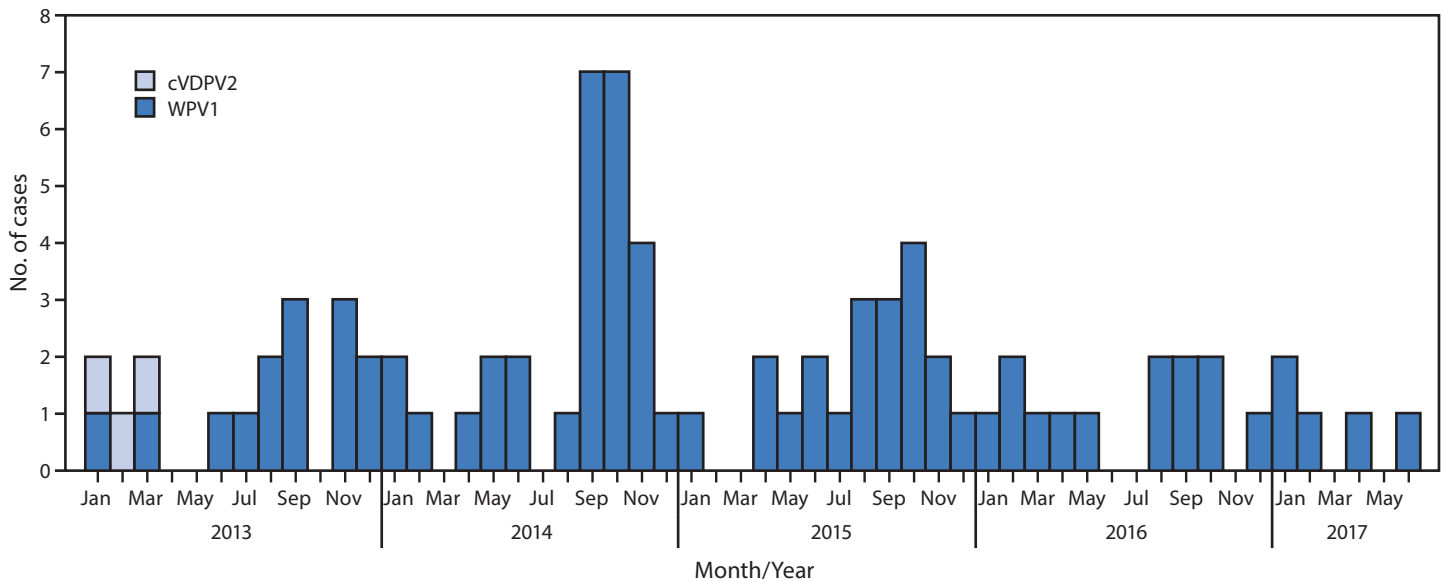
Epidemiology of WPV and Vaccine-Derived Poliovirus (VDPV) Cases

During 2016, 13 WPV1 cases were confirmed in Afghanistan, compared with 20 in 2015. Five cases were confirmed during January–June 2017, compared with six during the same period in 2016 (Figure 1) (Figure 2). Since 2014, when 28 cases were detected in Afghanistan, the number of WPV cases has declined each year. In 2016, the number of districts reporting polio cases had declined to four, from 16 in 2015. Seven (54%) of the 13 cases in 2016 were reported from Bermel district in the Southeastern province of Paktika, four (31%) were reported from Shigal wa Sheltan district of the Eastern province of Kunar, and one each (8%) was detected in the Southern provinces of Helmand (Nawzad district) and Kandahar (Shahwalikot district). As of June 2017, five cases have been reported, one from Kunduz province and two each from Helmand and Kandahar provinces. Among all 18 cases reported from January 2016 to June 2017, 13 were in children

FIGURE 1. Number of cases of wild poliovirus type 1 (WPV1) and circulating vaccine-derived poliovirus type 2 (cVDPV2), by month and year of paralysis onset — Afghanistan, 2013–2017

aged <36 months, seven of whom had never received OPV; one child had received 1 dose, two had received 2 doses, one had received 4 doses, and two had received ≥5 doses. Among the 18 patients, 16 had never received OPV through the routine immunization program.

Genomic sequence analysis of poliovirus cases and environmental isolates revealed multiple episodes of cross-border transmission in 2016–2017 from Pakistan to Afghanistan, with some sustained local transmission in Afghanistan. Among the seven positive environmental isolates identified from January 2016 to June 2017, five show closest genetic ties to Pakistan strains, with two indicating local circulation in Kandahar and Nangarhar. No cases of WPV3 or circulating vaccine-derived poliovirus type 2 (cVDPV2)** have been detected in Afghanistan since April 2010 and March 2013, respectively (Figure 1). In December of 2016, one ambiguous vaccine-derived poliovirus (aVDPV)[††] was detected in Bermel district of Paktika province.

Discussion

During the period covered by this report, the geographic scope and genetic diversity of WPV1 detected in Afghanistan has continued to decline from previous years. The polio

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** In severely underimmunized populations, high levels of susceptibility in children enable prolonged circulation of excreted vaccine-derived polioviruses in the community. Vaccine viruses that circulate uninterrupted for long periods can mutate and, over the course of 12–18 months, reacquire neurovirulence and can cause paralysis. These viruses are known as circulating vaccine-derived polioviruses (cVDPVs).

[††] aVDPVs are vaccine-derived polioviruses that are either isolated from persons with no known immunodeficiency, or isolated from sewage and whose ultimate source is unknown.

program in Afghanistan established a national emergency operations center (EOC) in 2015 and regional EOCs in 2016 to ensure that all regions of the country are monitored and receiving local support for polio activities. The 2016–2017 National Emergency Action Plan for polio includes a strong focus on management, accountability, and enhanced data quality along with interventions for reaching unreached children in both accessible and inaccessible areas. In addition to tracking mobile populations, the country has increased coordination with other international agencies such as the International Organization for Migration and the United Nations High Commissioner for Refugees and separated the high-risk mobile populations into four groups: 1) straddlers (persons who travel regularly between the border areas of Afghanistan and Pakistan), 2) long distance travelers, 3) nomads, and 4) returnees, with a uniquely targeted strategy for tracking each group's movement and vaccinating their children.

To improve the coordination between countries, the EOCs of Afghanistan and Pakistan established cross border focal points in 2016. Since then, the synchronization of campaigns, regular meetings, data sharing, and collaboration on case investigations and responses, cross-border vaccinations, and mobile population tracking have improved the ability to vaccinate children moving between the two countries.
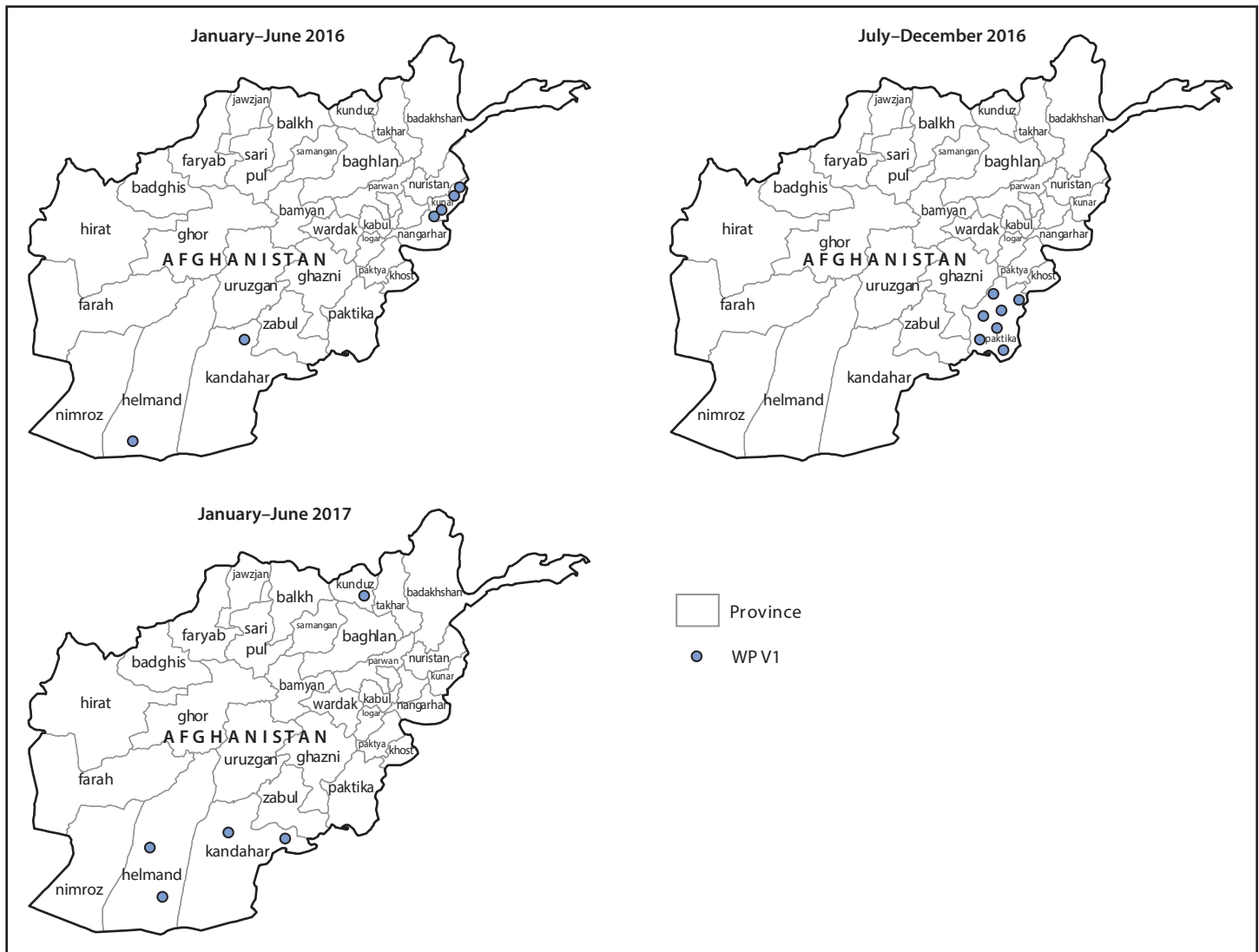
Although there have been noted improvements in SIAs, suboptimal campaign quality in Southern Afghanistan continues to be a challenge. The polio program has identified 47 districts where OPV-IPV SIAs have been conducted that are at very high risk for polio transmission. Microplans for polio SIAs are being revised to prioritize high-risk districts. Campaigns

FIGURE 2. Cases of wild poliovirus type 1 (WPV1), by province — Afghanistan, January 2016–June 2017*

* Each dot represents one case. Dots are randomly placed within provinces.

have been extended to include activities to better identify and vaccinate missed children. After 3 days of vaccination, teams now spend the fourth day reviewing data on missed children and planning targeted strategies to reach them on the fifth day. Independent campaign monitoring has been incorporated, particularly for areas with security challenges. Religious leaders are being engaged from the national to the community level to participate in social mobilization efforts.

Transit teams have been established in a more targeted manner at the entry and exit points into inaccessible areas and along travel routes. Cross-border teams are located at all formal and informal border crossing points. The use of community members as Immunization Communications Network volunteers has accelerated and is contributing to increases in acceptance of vaccination by families who had earlier refused

and in catching up missed children between campaigns. The Immunization Communications Network is also proving helpful in identifying high-risk mobile population groups and their movement patterns.

To accomplish eradication, it is essential that the polio program in Afghanistan continue to refine its strategies for vaccinating remaining pockets of missed children and reaching the high-risk mobile population. The polio program will benefit from completing its commitment to dedicate staff members' time to supporting routine immunization without compromising core polio-eradication activities. Detection of orphan viruses, which are >1% divergent from the most closely related isolate, indicating extended undetected circulation of poliovirus, along with continued close genetic linkages with Pakistan viruses, highlight the need for Afghanistan and Pakistan to continue to prioritize

coordination to improve surveillance, and to track and vaccinate their mobile populations, thereby stopping the ongoing cross-border transmission and reducing the risk for poliovirus circulation in hard-to-reach areas of Afghanistan.

Acknowledgments

Conflict of Interest

No conflicts of interest were reported.

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References

1. Global Polio Eradication Initiative. Annual report 2015. Geneva, Switzerland: World Health Organization; 2015. http://polioeradication. org/wp-content/uploads/2016/10/AR2015.pdf
2. Mbaeyi C, Shukla H, Smith P, et al. Progress toward poliomyelitis eradication—Afghanistan, January 2015−August 2016. MMWR Morb Mortal Wkly Rep 2016;65:1195–9. https://doi.org/10.15585/mmwr. mm6543a4
3. Mbaeyi C, Saatcioglu A, Tangermann RH, Hadler S, Ehrhardt D. Progress toward poliomyelitis eradication—Afghanistan, January 2014–August 2015. MMWR Morb Mortal Wkly Rep 2015;64:1166–70. https://doi. org/10.15585/mmwr.mm6441a2
4. World Health Organization. WHO vaccine-preventable diseases monitoring system: 2015 global summary. Geneva, Switzerland: World Health Organization; 2014. http://apps.who.int/immunization_ monitoring/globalsummary

Summary

What is already known about this topic?

Afghanistan is one of three countries where transmission of indigenous wild poliovirus (WPV) has never been interrupted. The Southern and Eastern regions of the country continue to be the main areas where WPV cases and positive environmental samples are identified.

What is added by this report?

The number of WPV type 1 cases reported in Afghanistan has declined yearly since 2014 when 28 cases were reported to 13 in 2016, indicating continued progress toward eradication. Factors contributing to this decline include increased focus on hard-to-reach populations, improved partner coordination, and successful negotiation to obtain access for campaigns, resulting in fewer children being missed during campaigns. During the October 2016 National Immunization Days (NIDs) 4.4% of children were missed because of security issues; <1% of children were missed because of insecurity during the May 2017 NIDs. The identification of a new corridor for transmission between Afghanistan and Pakistan in the Southeastern region, as well as ongoing case detection in the Southern region, highlight persistent immunity gaps.

What are the implications for public health practice?

To interrupt poliovirus transmission, Afghanistan's polio program will benefit from further refinement of strategies to vaccinate hard-to-reach populations and improve campaign quality, especially in the south. Prioritizing coordination between Afghanistan and Pakistan on surveillance and vaccination activities for their shared mobile populations is important to stop ongoing cross-border transmission and reduce the risk for poliovirus circulation in hard-to-reach areas of Afghanistan.

Effects of Antiretroviral Therapy to Prevent HIV Transmission to Women in Couples Attempting Conception When the Man Has HIV Infection — United States, 2017

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Existing U.S. guidelines recommend that men with human immunodeficiency virus (HIV) infection should achieve virologic suppression* with effective antiretroviral therapy (ART) before attempting conception (*1*). Clinical studies have demonstrated that effective ART profoundly reduces the risk for HIV transmission (*2–4*). This information might be useful for counseling couples planning a pregnancy in which the man has HIV infection and the woman does not (i.e., a mixed HIV-status couple, often referred to as a serodiscordant couple).

The risk for male-to-female sexual transmission of HIV in the absence of any prevention measures is estimated to be approximately 8 per 10,000 episodes of condomless intercourse (95% confidence intervals = 6–11) (*5*). Three multinational studies, HPTN 052 (*2*), PARTNER (*3*), and Opposites Attract (*4*), have provided data regarding the effectiveness of suppressing HIV replication with ART to reduce the risk for sexual HIV transmission. These studies followed approximately 3,000 sexually active mixed HIV-status couples over many years while they did not use condoms. The PARTNER and Opposites Attract studies quantified the extent of sexual exposure; 548 heterosexual couples (269 [49%] with a male HIV-infected partner) and 658 male-male couples from 14 European countries, Australia, Brazil, and Thailand engaged in >74,000 condomless episodes of vaginal or anal intercourse during >1,500 couple-years of observation (*3,4*). All three studies observed no HIV transmission to the uninfected partner while the partner with HIV was virologically suppressed with ART (*2–4*).

Recent studies have shown that men taking ART who have no detectable HIV RNA in their peripheral blood can occasionally have HIV genetic material detected in their semen (*6–8*). As many as 25% of men have had HIV RNA detected in semen after 3 months of viral suppression (*6*). After 4 or more months of suppression, reported detection rates in semen have been 5%–6% (*8*). In these studies, semen HIV RNA concentrations were 59–2,560 copies/mL (*6–8*). It is not known whether such detection represents the presence of replicating virus at sufficient concentration to transmit

infection. HPTN 052, PARTNER, and Opposite Attract have not reported data on HIV RNA detection in semen; however, in the context of the above-cited information, it is possible HIV RNA could have been present in some semen specimens but that concentrations of replication competent virus were insufficient to transmit infection (*2–4*).

Mixed HIV-status couples attempting conception can also reduce the risk for sexually transmitting HIV by decreasing the frequency of sexual contact and limiting condomless intercourse to the time of ovulation. Preexposure prophylaxis (PrEP), a highly effective HIV prevention method in which the partner without HIV takes antiretrovirals in advance of potential HIV exposure (*9*), can also reduce the risk for a woman who is attempting conception with an HIV-infected man, especially if his viral load is not known or is detectable (*1*). Semen processing with subsequent intrauterine insemination (IUI) or in vitro fertilization (IVF) also significantly and substantially reduces transmission of HIV from men to women (*10*). For some couples, semen processing combined with IUI or IVF might be an option, especially if fertility treatment is needed or if the man's HIV viral load cannot be fully suppressed. The extent to which any of these preventive interventions further decreases HIV risk below that associated with viral suppression and an undetectable viral load is unknown.

It is important that health care providers regularly assess mixed HIV-status couples' plans for conception. Considering factors such as risk tolerance, personal health, costs, and access to health care services, providers can help couples make the best decision for their personal circumstances.

Conflict of Interest

No conflicts of interest were reported.

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* Usually defined as a confirmed HIV RNA level <200 copies/mL or below the lower limits of detection of an ultrasensitive assay.

References

1. Panel on Treatment of HIV-Infected Pregnant Women and Prevention of Perinatal Transmission—a Working Group of the Office of AIDS Research Advisory Council (OARAC). AIDSinfo: recommendations for use of antiretroviral drugs in pregnant HIV-1-infected women for maternal health and interventions to reduce perinatal HIV transmission in the United States. Bethesda, MD: US Department of Health and Human Services, National Institutes of Health, Office of AIDS Research; 2016. https://aidsinfo.nih.gov/contentfiles/lvguidelines/perinatalgl.pdf
2. Cohen MS, Chen YQ, McCauley M, et al.; HPTN 052 Study Team. Antiretroviral therapy for the prevention of HIV-1 transmission. N Engl J Med 2016;375:830–9. https://doi.org/10.1056/NEJMoa1600693
3. Rodger AJ, Cambiano V, Bruun T, et al.; PARTNER Study Group. Sexual activity without condoms and risk of HIV transmission in serodifferent couples when the HIV-positive partner is using suppressive antiretroviral therapy. JAMA 2016;316:171–81. https://doi.org/10.1001/jama.2016.5148
4. Bavinton B, Grinsztejn B, Phanuphak N, et al.; Opposites Attract Study Group. HIV treatment prevents HIV transmission in male serodiscordant couples in Australia, Thailand and Brazil. Presented at the 9th IAS Conference on HIV Science (IAS 2017), Paris, France; July 25, 2017.
5. Boily MC, Baggaley RF, Wang L, et al. Heterosexual risk of HIV-1 infection per sexual act: systematic review and meta-analysis of observational studies. Lancet Infect Dis 2009;9:118–29. https://doi.org/10.1016/S1473-3099(09)70021-0
6. Politch JA, Mayer KH, Welles SL, et al. Highly active antiretroviral therapy does not completely suppress HIV in semen of sexually active HIV-infected men who have sex with men. AIDS 2012;26:1535–43. https://doi.org/10.1097/QAD.0b013e328353b11b
7. Politch JA, Mayer KH, Anderson DJ. HIV-1 is undetectable in preejaculatory secretions from HIV-1-infected men on suppressive HAART. AIDS 2016;30:1899–903. https://doi.org/10.1097/QAD.0000000000001130
8. Mujugira A, Coombs RW, Heffron R, et al.; Partners PrEP Study Team. Seminal HIV-1 RNA detection in heterosexual African men initiating antiretroviral therapy. J Infect Dis 2016;214:212–5. https://doi.org/10.1093/infdis/jiw131
9. US Public Health Service. Preexposure prophylaxis for the prevention of HIV infection in the United States—2014, a clinical practice guideline. Washington, DC: US Department of Health and Human Services; 2014. https://www.cdc.gov/hiv/pdf/prepguidelines2014.pdf
10. Kawwass JF, Smith DK, Kissin DM, et al. Strategies for preventing HIV infection among HIV-uninfected women attempting conception with HIV-infected men—United States. MMWR Morb Mortal Wkly Rep 2017;66:554–7. https://doi.org/10.15585/mmwr.mm6621a2

Notes from the Field

Death of a Farm Worker After Exposure to Manure Gas in an Open Air Environment — Wisconsin, August 2016

John M. Shutske, PhD[1]; Rebecca A. Larson, PhD[1]; Daniel M. Schaefer, PhD[2]; Liz Y. Binversie, MS[4]; Scott Rifleman[5]; Cheryl Skjolaas[1]

On August 15, 2016, at approximately 6:30 a.m., a previously healthy male employee of a Wisconsin beef farm was found dead near the edge of an outdoor 60,400 square foot (1.4 acre) manure storage basin (Figure). The basin was approximately 15 feet (4.6 meters) deep and nearly full. The victim, aged 29 years, was discovered by another worker; the coroner was notified at 6:50 a.m., and he pronounced the victim dead at the scene. Thirteen dead cattle were discovered in an adjoining pen; three others were struggling to stand and were euthanized. The owner of the farm reported that at 3:00 a.m., the victim had used a tractor-powered agitator to agitate the manure,* which a contractor was scheduled to pump and spread on cropland later that morning. The last contact from the victim was a social media post at 4:10 a.m. At the time he was discovered, he was approximately 3 feet downslope from the rear of the tractor, which was running.

Weather conditions from a nearby airport reported temperatures at 4:15 a.m., 5:15 a.m., and 6:15 a.m. of 54.5°F (12.5°C), 53.6°F (12.0°C), and 52.9°F (11.6°C), respectively, with no wind. The high temperature the previous day was 80°F (26.7°C), and reached 87°F (30.6°C) the preceding week (August 7–13), which was 10°F (5.6°C) warmer than the historical weekly average. Relative humidity measured at the nearby airport during these same time intervals ranged from 97% to 100%. The National Weather Service's Green Bay office documented a temperature inversion in the area that morning, citing warmer air temperatures 1,000–1,300 feet (300–400 meters) above ground level.

The man's death was initially attributed to methane, a physiologically inert gas produced through anaerobic decomposition of organic matter in manure and released through liquid manure. Methane deaths are usually the result of asphyxiation (1). The coroner reported foam coming from the decedent's mouth and nose, suggesting pulmonary edema; there was no indication of external trauma, and an autopsy was not conducted. A University of Wisconsin farm safety expert advised the coroner to test the decedent's blood for evidence

FIGURE. Open-air manure pit and site of death of a worker on a beef farm — Wisconsin, August 2016

Source: Google Earth.

of hydrogen sulfide exposure; blood thiosulfate level was 9.2 μg/ml, consistent with lethal hydrogen sulfide exposure as the cause of death (2). The cattle deaths were also assumed to have resulted from hydrogen sulfide exposure, although this was not laboratory-confirmed.

University staff members visited the farm on September 26, 2016, to ascertain potential sources of sulfur that might have caused elevated hydrogen sulfide levels in the stored manure, such as gypsum animal bedding (3). Ambient air was not tested, because no agitation was occurring at the time of the visit, and weather conditions were considerably different than they had been on the day of the event. Although no gypsum was used, the animals' diet did include distiller's syrup, a by-product of corn-based ethanol production. The sulfur concentration in a tested syrup sample (collected the day of the visit, stored in

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* This agitator was attached to a tractor and driven by a rotating shaft exiting the rear of the tractor. The agitator extended approximately 40 feet (12 meters) outward into the liquid slurry. Agitation action includes a large, rotating propeller that stirs aggressively. The agitator also pumps and sprays the thick liquid backward or to the side to move the manure and break up crusted surfaces.

† Occupational Safety and Health Administration documents lethal concentrations to be 700–1000 parts per million with "rapid unconsciousness, 'knockdown' or immediate collapse within 1 to 2 breaths, breathing stops, death within minutes." (https://www.osha.gov/SLTC/hydrogensulfide/hazards.html.) In addition, the relative gas density of hydrogen sulfide is 1.19 (https://www.cdc.gov/niosh/npg/npgd0337.html); hydrogen sulfide gas is heavier than air, so the gas being released during agitation was less likely to be dispersed and remained close to the ground surface.

a refrigerator, and tested on January 20, 2017) was 1.53% of dry matter; 18–20 pounds of syrup were fed per day to each animal. At the recommendation of a cattle nutritionist, the farmer was providing thiamine supplementation to prevent polioencephalomalacia, a neurologic disease of ruminants that has been associated with thiamine status and high sulfur intake (4). Previous laboratory tests of the herd's mixed feed analyzed on September 16, 2016, found a sulfur concentration of 0.44% of diet dry matter. Cattle nutrition references recommend that for feedlot cattle, the maximum tolerable limit for dietary sulfur is 0.3% of diet dry matter, with 0.15% considered sufficient (5).

Manure tested twice during the previous year had sulfur levels of 9.67 and 6.94 pounds per thousand gallons for samples tested on April 15, 2015, and November 9, 2015, respectively. No additional manure samples were taken immediately before or after the incident. The average manure sulfur level for Wisconsin beef operations is 1.6 pounds per thousand gallons (6).

Asphyxiation deaths associated with manure storage typically occur in confined spaces not intended for continuous occupancy (1). This incident was unusual because human and cattle deaths occurred in an outdoor, ambient air environment. It is possible that the temperature inversion and zero wind velocity suppressed air mixing, leading to an accumulation of lethal concentrations of hydrogen sulfide at ground level as agitation occurred.[†] Additional research on the impact of weather and other environmental conditions on outdoor gas dispersion, as well as production practices that increase hydrogen sulfide exposure risk is needed. Monitoring for toxic gases and adequate oxygen is important even near outdoor manure storage sites. Improved understanding of factors that contribute to toxic outdoor hydrogen sulfide concentrations is needed to develop worker safety recommendations and to inform outdoor air monitoring strategies. Public health officials and forensic toxicologists who evaluate manure gas incidents should always consider tests for hydrogen sulfide exposure. Farm owners, operators, and employees, as well as professional and volunteer responders in rural areas, should receive additional manure gas education that includes information about hydrogen sulfide, other lethal gases, and the production practices and conditions that increase risk.

Conflict of Interest

No conflicts of interest were reported.

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References

1. CDC. Fatalities attributed to methane asphyxia in manure waste pits—Ohio, Michigan, 1989. MMWR Morb Mortal Wkly Rep 1989;38:583–6.
2. Kage S, Kashimura S, Ikeda H, Kudo K, Ikeda N. Fatal and nonfatal poisoning by hydrogen sulfide at an industrial waste site. J Forensic Sci 2002;47:652–5.
3. Meinen R, Brandt RC, Elliott HA, Hofstetter D. Operator exposure to hydrogen sulfide from dairy manure storages containing gypsum bedding. J Agric Saf 2017;23:9–22. https://doi.org/10.13031/jash.11563
4. Amat S, Olkowski A, Atila M, O'Neill TJ. A review of polioencephalomalacia in ruminants: is the development of malacic lesions associated with excess sulfur intake independent of thiamine deficiency? Vet Med Anim Sci 2013;1:1–10. https://doi.org/10.7243/2054-3425-1-1
5. National Academies of Sciences, Engineering, and Medicine. Nutrient requirements of beef cattle. 8th ed. Washington, DC: The National Academies Press; 2016.
6. Laboski CA, Peters JB. Nutrient application guidelines for field, vegetable, and fruit crops in Wisconsin. Madison, Wisconsin: University of Wisconsin Extension; 2012. http://learningstore.uwex.edu/assets/pdfs/A2809.pdf

Errata

Vol. 66, No. 21

In the report, "Strategies for Preventing HIV Infection Among HIV-Uninfected Women Attempting Conception with HIV-Infected Men — United States," on page 555, the first full paragraph should have read as follows: "Condomless intercourse is associated with the highest risk for HIV transmission. The risk for male-to-female transmission in HIV-discordant couples has been estimated as approximately **8 per 10,000 episodes of condomless intercourse** (*10*). This estimation of risk is based, however, on natural history studies of couples before routine availability of HIV viral load measurements and HAART, and might vary widely with characteristics of the man and woman, including the presence of other sexually transmitted diseases, inflammation within the genital tract, and viral load of the infected partner (*10*). Some studies suggest a parallel reduction in plasma and semen viral loads (*11*), but other evidence suggests that plasma and semen viral loads might not correlate (*12*); men with undetectable plasma viral loads have had virus isolated from their semen (*13*). **Nonetheless, in a study that assessed sexual transmission risk during condomless intercourse in persons treated with HAART, the risk was lower among persons treated with HAART than among those not treated (hazard ratio 0.04, 95% confidence interval [CI] = 0.01–0.27) (*14*); not all treated were necessarily fully suppressed at the estimated time of transmission. Based on this study, for discordant couples in which the man is treated with HAART, the postulated risk for transmission to a female partner during condomless intercourse would be 0.32 per 10,000 exposures (95% CI = 0.06–1.7) (*10*).** In addition to viral suppression with HAART, the risk for sexual transmission can be further reduced by minimizing exposure frequency and limiting condomless intercourse to time of ovulation, thereby maximizing the chance of conception, and by use of PrEP by the uninfected partner (*3*)."

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In the report "Pneumococcal Vaccination Among Medicare Beneficiaries Occurring After the Advisory Committee on Immunization Practices Recommendation for Routine Use Of 13-Valent Pneumococcal Conjugate Vaccine and 23-Valent Pneumococcal Polysaccharide Vaccine for Adults Aged ≥65 Years," on page 732, the second sentence of the discussion should have read "However, approximately 20%–25% of IPD cases and 10% of community-acquired pneumonia cases in adults aged ≥65 years are caused by **PCV13 serotypes**."

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage* of Currently Employed Adults[†] with No Health Insurance,[§] by Type of Work Arrangement[¶] — National Health Interview Survey, 2010 and 2015**
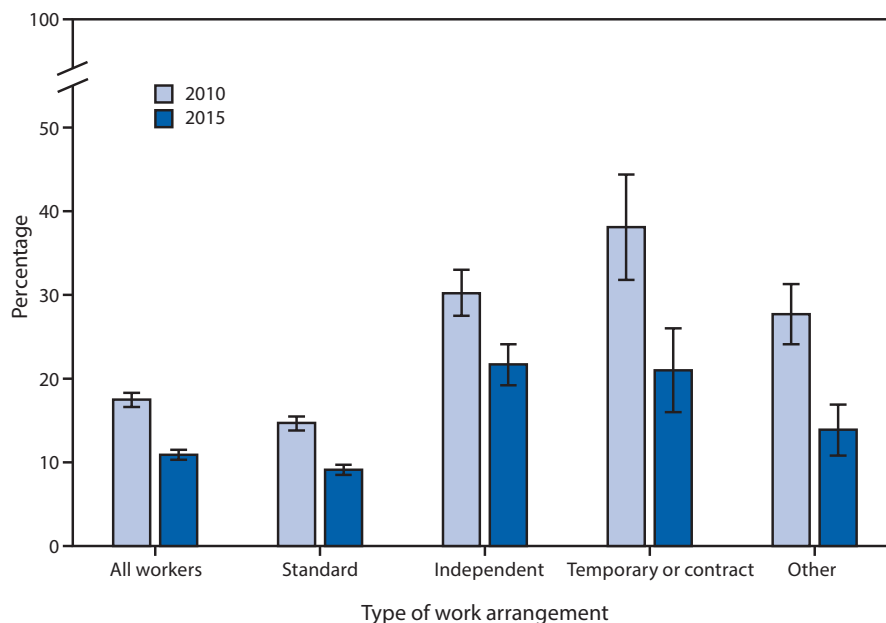
* With 95% confidence intervals indicated with error bars.
[†] Persons working for pay at a job or business, being with a job or business but not at work, or working not for pay at a family-owned job or business a week before the time of the interview.
[§] Persons having no health insurance at the time of the interview under private health insurance, Medicare, Medicaid, a state-sponsored health plan, other government programs, or military health plan.
[¶] Based on responses to a question that asked, "The next question refers to your current, main job. Which of the following best describes your work arrangement? "The responses were classified into four categories: 1) Standard: a regular, permanent employee, 2) Independent: work as an independent contractor, independent consultant or freelance worker, 3) Temporary or contract: paid by a temporary agency or work for a contractor who provides workers and services to others under contract), 4) Other: some other work arrangement.
** Estimates were based on a sample of the U.S. civilian, noninstitutionalized population aged ≥18 years. Adults who were not currently employed at the time of interview were not included in the denominators when calculating percentages.

The percentage of all workers with no health insurance decreased from 17.5% in 2010 to 10.9% in 2015. The percentage also declined in each type of work arrangement. In 2015, independent workers (21.7%) or temporary/contract workers (21.0%) were more likely to lack health insurance than workers with a standard work arrangement (9.1%).

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

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