Short Sleep Duration Among Middle School and High School Students — United States, 2015

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Insufficient sleep among children and adolescents is associated with increased risk for obesity, diabetes, injuries, poor mental health, attention and behavior problems, and poor academic performance (*1–4*). The American Academy of Sleep Medicine has recommended that, for optimal health, children aged 6–12 years should regularly sleep 9–12 hours per 24 hours and teens aged 13–18 years should sleep 8–10 hours per 24 hours (*1*). CDC analyzed data from the 2015 national, state, and large urban school district Youth Risk Behavior Surveys (YRBSs) to determine the prevalence of short sleep duration (<9 hours for children aged 6–12 years and <8 hours for teens aged 13–18 years) on school nights among middle school and high school students in the United States. In nine states that conducted the middle school YRBS and included a question about sleep duration in their questionnaire, the prevalence of short sleep duration among middle school students was 57.8%, with state-level estimates ranging from 50.2% (New Mexico) to 64.7% (Kentucky). The prevalence of short sleep duration among high school students in the national YRBS was 72.7%. State-level estimates of short sleep duration for the 30 states that conducted the high school YRBS and included a question about sleep duration in their questionnaire ranged from 61.8% (South Dakota) to 82.5% (West Virginia). The large percentage of middle school and high school students who do not get enough sleep on school nights suggests a need for promoting sleep health in schools and at home and delaying school start times to permit students adequate time for sleep.

The Youth Risk Behavior Surveillance System was designed to estimate the prevalence of health risk behaviors among students that contribute to the leading causes of death and disability in the United States at the national, state, territorial, tribal, and large urban school district levels.* Students complete

an anonymous, voluntary, school-based paper-and-pencil questionnaire during a regular class period after the school obtains parental permission according to local procedures. The national high school YRBS is conducted by CDC. It uses a three-stage cluster sample design to obtain a nationally representative sample of students in public and private schools in grades 9–12 (*5*). In 2015, the student sample size was 15,624.† The school and student response rates were 69% and 86%, respectively, resulting in an overall response rate of 60%.§

State and large urban school district high school and middle school surveys are conducted by health and education

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* https://www.cdc.gov/healthyyouth/data/yrbs/overview.htm.

† https://www.cdc.gov/healthyyouth/data/yrbs/pdf/2015/ss6506_updated.pdf.

§ Overall response rate = school response rate x student response rate ([number of participating schools/number of eligible sampled schools] x [number of usable questionnaires/number of eligible students sampled]).

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

departments using a two-stage cluster sample designed to produce representative samples of students in each jurisdiction (5). These surveys are independent of CDC's national YRBS and, unlike the national YRBS, are representative of only public school students, except in one state. To be included in this report, states and large urban school districts had to 1) have at least a 60% overall response rate, 2) include a question on sleep duration, and 3) provide permission for CDC to include their data. Thirty states and 16 large urban school districts administered a high school YRBS and met these criteria. Across these states, the student sample sizes ranged from 1,313 (South Dakota) to 55,596 (Maryland).¶ The median overall response rate was 66.5% and ranged from 60% (Indiana and North Carolina) to 84% (Virginia). Across these large urban school districts, the high school student sample sizes ranged from 1,413 (Broward County, Florida) to 10,419 (District of Columbia). The median overall response rate was 76.5% and ranged from 64% (District of Columbia) to 88% (San Diego, California).

Nine states and seven large urban school districts administered a middle school YRBS and met these criteria. Across these states, the student sample sizes ranged from 1,640 (Kentucky) to 27,104 (Maryland). The median overall response rate was 76% and ranged from 68% (Maine) to 85% (Hawaii and Virginia). Across these large urban school districts, the middle school student sample sizes ranged from 1,333

¶ https://www.cdc.gov/healthyyouth/data/yrbs/pdf/2015/ss6506_updated.pdf.

(Los Angeles, California) to 4,533 (Duval County, Florida). The median overall response rate was 81% and ranged from 68% (San Francisco, California) to 86% (Orange County, Florida). All data sets were weighted to be representative of students in the jurisdiction.

All students in the national, state, and large urban school district surveys were asked to respond to this question about sleep duration: "On an average school night, how many hours of sleep do you get?" Possible responses were 4 or less hours, 5 hours, 6 hours, 7 hours, 8 hours, 9 hours, and 10 or more hours. Short sleep duration was defined as <9 hours for students aged 6–12 years and <8 hours for those aged 13–18 years. The analytic samples were composed of students who responded to both the sleep duration question and the age question.**

Prevalences and 95% confidence intervals (CIs) of short sleep duration on an average school night were calculated overall and by sex, grade, and race/ethnicity for the national high school YRBS and for a combined data set composed of data from the nine states that included the sleep duration question in a middle school YRBS. This combined data set is not nationally representative. The overall prevalence and 95% CI

** In response to the question "How old are you?" middle school students could select from "10 years old or younger, 11 years old, 12 years old, 13 years old, 14 years old, 15 years old, or 16 years old or older"; high school students could select from "12 years old or younger, 13 years old, 14 years old, 15 years old, 16 years old, 17 years old, or 18 years old or older." High school students who reported being "18 years old or older" were considered to have a short sleep duration if they reported <8 hours of sleep on an average school night.

of short sleep duration also were calculated separately for each state and large urban school district at both middle school and high school levels. Pairwise differences in short sleep duration prevalence among sex, grade, and race/ethnicity subgroups were determined using t-tests; differences among estimates were considered statistically significant if the t-test p-value was <0.05. Analyses accounted for the weighting of the data and for the complex sampling designs.

The overall prevalence of short sleep duration among middle school students in the nine states combined was 57.8% (Table 1). The distribution of sleep duration was 5.9% for ≤4 hours, 6.0% for 5 hours, 11.0% for 6 hours, 20.0% for 7 hours, 29.9% for 8 hours, 17.2% for 9 hours, and 10.0% for ≥10 hours. The prevalence of short sleep duration in this combined sample was higher among female students (59.6%) than among male students (56.0%). The prevalence of short sleep duration also was highest among students in grade 6 (61.3%), lowest among students in grade 8 (53.1%), and higher among black (61.1%) and Native Hawaiian/Pacific Islander (64.2%) students than among white (56.6%), Hispanic (57.3%), and Asian (55.5%) students. State-specific estimates of short sleep duration ranged from 50.2% (New Mexico) to 64.7% (Kentucky). Prevalence estimates for the seven large urban school districts ranged from 50.2% (San Francisco, California) to 61.8% (Miami-Dade County, Florida).

At the high school level, nationwide, the prevalence of short sleep duration was 72.7% (Table 2). The distribution of sleep duration was 7.5% for ≤4 hours, 12.6% for 5 hours, 22.9% for 6 hours, 29.7% for 7 hours, 20.6% for 8 hours, 5.0% for 9 hours, and 1.7% for ≥10 hours. The prevalence of short sleep duration was higher among female students (75.6%) than among male students (69.9%), lower among students in grade 9 (65.6%) than in other grades (71.7%–77.6%), and higher among black (76.5%) and Asian (79.3%) students than white (72.0%) and Hispanic (70.2%) students. State-level estimates of short sleep duration for the 30 states ranged from 61.8% (South Dakota) to 82.5% (West Virginia) (Table 2) (Figure). Prevalence estimates for the 16 large urban school districts ranged from 69.9% (Los Angeles, California) to 85.6% (Broward County, Florida).

Discussion

Children and adolescents who do not get the recommended amount of sleep for their age are at increased risk for chronic conditions such as diabetes, obesity, and poor mental health, as well as injuries, attention and behavioral problems, and poor academic performance (1–4). In addition, short sleep duration has been found to be associated with engaging in health- and injury-related risk behaviors among high school

TABLE 1. Prevalence of short sleep duration* on an average school night among middle school students in nine states combined and among nine states and seven large urban school districts, by selected characteristics — Youth Risk Behavior Surveys, 2015

Site/Characteristic	No.[†]	Prevalence % (95% CI)
Nine state surveys combined[§]	52,356	57.8 (56.7–58.9)
Sex		
Female	26,549	59.6 (58.2–61.0)[¶]
Male	25,608	56.0 (54.6–57.4)[¶]
Grade		
6	14,060	61.3 (59.5–63.0)[**,††]
7	19,153	59.2 (57.8–60.5)[§§,††]
8	18,707	53.1 (51.6–54.7)[§§,**]
Race/Ethnicity		
White[¶¶]	23,434	56.6 (54.9–58.4)[***,†††]
Black[¶¶]	7,638	61.1 (59.0–63.1)[§§§,¶¶¶,****]
Hispanic	8,384	57.3 (55.3–59.3)[***,†††]
Asian[¶¶]	2,644	55.5 (51.0–59.8)[***,†††]
American Indian/Alaska Native[¶¶]	1,302	59.4 (55.3–63.4)
Native Hawaiian/Pacific Islander[¶¶]	2,075	64.2 (59.1–68.9)[§§§,¶¶¶,****]
State surveys		
Delaware	2,883	58.8 (56.7–60.9)
Florida	5,472	56.9 (54.9–58.9)
Hawaii	5,704	61.3 (57.4–65.0)
Kentucky	1,603	64.7 (61.7–67.5)
Maine	4,852	53.0 (50.8–55.1)
Maryland	24,938	58.7 (57.5–59.9)
New Mexico	2,961	50.2 (48.2–52.3)
Virginia	2,133	56.3 (53.7–58.9)
West Virginia	1,810	64.1 (60.7–67.4)
Large urban school district surveys		
Broward County, Florida	1,447	62.0 (58.7–65.2)
Duval County, Florida	4,259	58.5 (56.7–60.2)
Houston, Texas	2,326	58.3 (55.5–60.9)
Los Angeles, California	1,223	54.2 (50.8–57.5)
Miami-Dade County, Florida	2,129	61.8 (58.9–64.6)
Orange County, Florida	1,799	53.1 (50.4–55.8)
San Francisco, California	1,861	50.2 (47.0–53.4)

Abbreviation: CI = confidence interval.
  * Short sleep duration defined as <9 hours for students aged 6–12 years and <8 hours for students aged 13–18 years.
  † Unweighted number of survey respondents. Categories might not sum to sample total because of missing responses.
  § A combined data set using data from nine state surveys (Delaware, Florida, Hawaii, Kentucky, Maine, Maryland, New Mexico, Virginia, and West Virginia) that is not nationally representative.
  ¶ Significantly different by sex (p<0.05).
  ** Significantly different from grade 7 (p<0.05).
  †† Significantly different from grade 8 (p<0.05).
  §§ Significantly different from grade 6 (p<0.05).
  ¶¶ Non-Hispanic.
  *** Significantly different from black students (p<0.05).
  ††† Significantly different from Native Hawaiian/Pacific Islander students (p<0.05).
  §§§ Significantly different from white students (p<0.05).
  ¶¶¶ Significantly different from Hispanic students (p<0.05).
  **** Significantly different from Asian students (p<0.05).

students (6,7). The national high school YRBS has included a question about sleep duration since 2007, and it is used to track the progress of the *Healthy People 2020* sleep objective for this population (Sleep Health Objective 3: Increase the proportion

TABLE 2. Prevalence of short sleep duration* on an average school night among high school students, nationwide and among 30 states and 16 large urban school districts, by selected characteristics — Youth Risk Behavior Surveys, 2015

Site/Characteristic	No.[†]	Prevalence % (95% CI)
National survey	**14,471**	**72.7 (70.4–74.9)**
Sex		
Female	7,250	75.6 (73.3–77.7)[§]
Male	7,165	69.9 (66.9–72.7)[§]
Grade		
9	3,673	65.6 (62.6–68.5)[¶,**,††]
10	3,593	71.7 (69.2–74.0)[§§,**,††]
11	3,695	77.1 (73.5–80.3)[§§,¶]
12	3,426	77.6 (74.7–80.2)[§§,¶]
Race/Ethnicity		
White[¶¶]	6,592	72.0 (69.5–74.4)[***,†††]
Black[¶¶]	1,381	76.5 (72.8–79.9)[§§§,¶¶¶]
Hispanic	4,729	70.2 (66.6–73.5)[***,†††]
Asian[¶¶]	606	79.3 (72.2–85.0)[§§§,¶¶¶]
American Indian/Alaska Native[¶¶]	150	75.0 (60.0–85.7)
Native Hawaiian/Pacific Islander[¶¶]	86	—[****]
State surveys		
Alabama	1,505	72.0 (69.1–74.7)
Arkansas	2,656	70.7 (66.3–74.7)
California	1,894	71.0 (65.1–76.3)
Connecticut	2,167	80.1 (78.3–81.9)
Delaware	2,503	75.7 (73.1–78.1)
Florida	6,057	76.9 (75.4–78.3)
Hawaii	5,528	75.3 (72.7–77.8)
Illinois	3,043	76.7 (73.9–79.3)
Indiana	1,871	78.6 (76.2–80.8)
Kentucky	2,495	75.7 (72.7–78.5)
Maryland	52,043	76.2 (75.5–76.9)
Massachusetts	3,015	78.0 (75.7–80.2)
Michigan	4,717	79.8 (77.1–82.2)[§]
Missouri	1,432	72.6 (69.0–75.9)
Montana	4,371	67.4 (65.6–69.2)
Nebraska	1,449	68.1 (64.5–71.4)
Nevada	1,393	75.9 (73.2–78.4)
New Hampshire	13,903	71.6 (70.1–73.1)
New Mexico	7,787	68.3 (66.7–69.8)
New York	8,129	78.1 (75.8–80.3)
North Carolina	5,683	75.0 (71.4–78.3)
North Dakota	2,094	70.5 (67.8–73.0)
Oklahoma	1,586	71.8 (68.5–74.9)

TABLE 2. (*Continued*) Prevalence of short sleep duration* on an average school night among high school students, nationwide and among 30 states and 16 large urban school districts, by selected characteristics — Youth Risk Behavior Surveys, 2015

Site/Characteristic	No.[†]	Prevalence % (95% CI)
Pennsylvania	2,715	74.3 (71.9–76.6)
South Carolina	1,272	72.1 (68.0–75.8)
South Dakota	1,296	61.8 (57.6–65.8)
Tennessee	4,015	70.7 (69.1–72.2)
Virginia	4,264	72.8 (70.4–75.1)
West Virginia	1,561	82.5 (79.2–85.3)
Wyoming	2,328	69.8 (67.7–71.7)
Large urban school district surveys		
Boston, Massachusetts	1,547	82.4 (79.8–84.7)
Broward County, Florida	1,327	85.6 (83.3–87.6)
Cleveland, Ohio	1,434	80.0 (77.7–82.1)
DeKalb County, Georgia	1,814	80.4 (78.3–82.5)
District of Columbia	10,281	71.6 (70.5–72.7)
Duval County, Florida	3,153	81.1 (79.1–83.0)
Houston, Texas	2,878	75.6 (73.5–77.6)
Los Angeles, California	2,189	69.9 (66.3–73.3)
Miami-Dade County, Florida	2,629	80.4 (77.9–82.7)
New York City, New York	5,972	74.8 (72.4–77.1)
Oakland, California	1,512	70.6 (66.7–74.2)
Orange County, Florida	1,421	79.3 (76.2–82.1)
Palm Beach, Florida	2,284	81.5 (79.2–83.6)
Philadelphia, Pennsylvania	1,464	80.3 (77.1–83.2)
San Diego, California	2,249	71.9 (68.8–74.9)
San Francisco, California	2,005	75.2 (72.3–77.9)

Abbreviation: CI = confidence interval.
* Short sleep duration defined as <9 hours for students aged 6–12 years and <8 hours for students aged 13–18 years.
† Unweighted number of survey respondents. Categories might not sum to sample total because of missing responses.
§ Significantly different by sex (p<0.05).
¶ Significantly different from grade 10 (p<0.05).
** Significantly different from grade 11 (p<0.05).
†† Significantly different from grade 12 (p<0.05).
§§ Significantly different from grade 9 (p<0.05).
¶¶ Non-Hispanic.
*** Significantly different from black students (p<0.05).
††† Significantly different from Asian students (p<0.05).
§§§ Significantly different from white students (p<0.05).
¶¶¶ Significantly different from Hispanic students (p<0.05).
**** Unreliable estimate. Denominator <100 students.

of students in grades 9 through 12 who get sufficient sleep).[††] Nationally, no progress has been made toward this objective: the percentage of high school students who get sufficient sleep has substantially decreased from 30.9% in 2009, the baseline year for this objective, to 27.3% in 2015, the latest year of available data.[§§] A question about sleep duration was included for the first time in 2015 in the standard middle school and high school YRBS questionnaires used as the starting point for the state and large urban school district YRBS questionnaires.

As a result, evidence now exists that short sleep duration is prevalent among middle school students as well as high school students. In addition, at both middle and high school levels, in every state and large urban school district with YRBS data about sleep duration, a majority of students reported getting less than the recommended amount of sleep.

The findings in this report are subject to at least four limitations. First, sleep duration was obtained by self-report and was not verified by objective measures such as actigraphy (sensor measurement of motor activity) or polysomnography (sleep study). Second, a national YRBS is not conducted among middle school students. The middle school findings from the combined data set cannot be generalized to the entire United

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FIGURE. Prevalence of short sleep duration* on an average school night among high school students, by state — Youth Risk Behavior Survey, 2015

76.0–82.5
72.0–75.9
61.8–71.9
No data

* Short sleep duration defined as <9 hours for students aged 6–12 years and <8 hours for students aged 13–18 years.

Summary

What is already known about this topic?

Insufficient sleep among children and adolescents is associated with an increased risk for obesity, diabetes, injuries, poor mental health, attention and behavior problems, and poor academic performance. Nationwide, approximately two thirds of U.S. high school students report sleeping <8 hours per night on school nights.

What is added by this report?

This is the first report to provide state-level estimates of short sleep duration among middle school and high school students using age-specific recommendations from the American Academy of Sleep Medicine. A majority of both middle school and high school students in states and large urban school districts included in this report get less than the recommended amount of sleep, putting them at an increased risk for several chronic conditions.

What are the implications for public health practice?

The finding that a large percentage of middle school and high school students who do not get enough sleep on school nights provides an opportunity for promoting sleep health in schools, including addition of sleep health to curricula and delaying school start times to permit students adequate time for sleep.

States. Third, at both middle and high school levels, state-level data are not available for states that did not administer the YRBS, did not include a question about sleep duration on their YRBS, or did not achieve a high enough overall response rate to obtain weighted data. Finally, YRBS data are representative only of students enrolled in school; in 2015, less than 5% of children aged 7–17 years were not enrolled in school.[¶¶]

To ensure their children get enough sleep, parents can support the practice of good sleep habits. One important habit is maintaining a consistent sleep schedule during the school week and weekends. Parent-set bedtimes have been linked to getting enough sleep among adolescents (8). Evening light exposure and technology use are also associated with less sleep among adolescents (9). Parents can limit children's permitted use of electronic devices in terms of time (e.g., only before a specific time, sometimes referred to as a "media curfew") and place (e.g., not in their child's bedroom) Other tips for better sleep are available at https://www.cdc.gov/sleep/about_sleep/sleep_hygiene.html. One meta-analysis of school-based sleep education programs found that they produced significantly longer weekday and weekend total sleep time immediately after completion, but that these improvements were not maintained at follow-up (10). Researchers designing such programs might consider incorporating refresher sessions to maintain improvements in sleep duration and sleep hygiene (i.e., habits that support good sleep). School districts can also support adequate sleep among students by implementing delayed

school start times as recommended by the American Academy of Pediatrics,*** the American Medical Association,[†††] and the American Academy of Sleep Medicine.[§§§]

*** http://pediatrics.aappublications.org/content/early/2014/08/19/peds.2014-1697.
[†††] https://www.ama-assn.org/ama-supports-delayed-school-start-times-improve-adolescent-wellness.
[§§§] http://www.aasmnet.org/articles.aspx?id=6847.

Conflict of Interest

No conflicts of interest were reported.

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Population-Based Surveillance of Birth Defects Potentially Related to Zika Virus Infection — 15 States and U.S. Territories, 2016

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Zika virus infection during pregnancy can cause serious birth defects, including microcephaly and brain abnormalities (*1*). Population-based birth defects surveillance systems are critical to monitor all infants and fetuses with birth defects potentially related to Zika virus infection, regardless of known exposure or laboratory evidence of Zika virus infection during pregnancy. CDC analyzed data from 15 U.S. jurisdictions conducting population-based surveillance for birth defects potentially related to Zika virus infection.* Jurisdictions were stratified into the following three groups: those with 1) documented local transmission of Zika virus during 2016; 2) one or more cases of confirmed, symptomatic, travel-associated Zika virus disease reported to CDC per 100,000 residents; and 3) less than one case of confirmed, symptomatic, travel-associated Zika virus disease reported to CDC per 100,000 residents. A total of 2,962 infants and fetuses (3.0 per 1,000 live births; 95% confidence interval [CI] = 2.9–3.2) (*2*) met the case definition.† In areas with local transmission there was a non-statistically significant increase in total birth defects potentially related to Zika virus infection from 2.8 cases per 1,000 live births in the first half of 2016 to 3.0 cases in the second half (p = 0.10). However, when neural tube defects and other early brain malformations (NTDs)§ were excluded, the prevalence of birth defects strongly linked to congenital Zika virus infection increased significantly, from 2.0 cases per 1,000 live births in the first half of 2016 to 2.4 cases in the second half, an increase of 29 more cases than expected (p = 0.009). These findings underscore the importance of surveillance for birth defects potentially related to Zika virus infection and the need for continued monitoring in areas at risk for Zika.

In 2016, as part of the emergency response to the Zika virus outbreak in the World Health Organization's Region of the Americas, population-based birth defects surveillance systems monitored fetuses and infants with birth defects potentially related to Zika virus infection using a standard case definition and multiple data sources. Medical records were abstracted for data on birth defects, congenital infections, pregnancy outcome, head circumference, vital status, and Zika laboratory test results, irrespective of maternal Zika virus exposure or infection. Verbatim text describing the birth defects was reviewed to identify those that met the case definition. Infants and fetuses were aggregated into four mutually exclusive categories: those with 1) brain abnormalities or microcephaly; 2) NTDs; 3) eye abnormalities without mention of a brain abnormality included in the two previously defined categories; and 4) other consequences of central nervous system (CNS) dysfunction, specifically joint contractures and congenital sensorineural deafness without mention of brain or eye abnormalities included in another category. Because the evidence linking NTDs and congenital Zika virus infection is weak, prevalence estimates per 1,000 live births were calculated both overall and excluding NTDs for each quarter in 2016; CIs were calculated using Poisson regression (*1,2*).

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* With population-based surveillance for birth defects potentially related to Zika virus infection, information is collected on all infants who have birth defects that might be related to Zika virus infection. This includes infants who have not been exposed to Zika virus and might have the same birth defects for other reasons. This helps to identify the full spectrum of outcomes associated with Zika virus infection. https://www.cdc.gov/pregnancy/zika/research/birth-defects.html.

† Brain abnormalities or microcephaly (congenital microcephaly [head circumference <3rd percentile for gestational age and sex], intracranial calcifications, cerebral atrophy, abnormal cortical gyral patterns [e.g., polymicrogyria, lissencephaly, pachygyria, schizencephaly, and gray matter heterotopia], corpus callosum abnormalities, cerebellar abnormalities, porencephaly, hydranencephaly, ventriculomegaly/hydrocephaly [excluding "mild" ventriculomegaly without other brain abnormalities], fetal brain disruption sequence [collapsed skull, overlapping sutures, prominent occipital bone, and scalp rugae], and other major brain abnormalities); neural tube defects and other early brain malformations (anencephaly/acrania, encephalocele, spina bifida, and holoprosencephaly); structural eye abnormalities (microphthalmia/anophthalmia, coloboma, cataract, intraocular calcifications, and chorioretinal anomalies [e.g., atrophy and scarring, gross pigmentary changes, excluding retinopathy of prematurity]; optic nerve atrophy, pallor, and other optic nerve abnormalities); consequences of central nervous system dysfunction (arthrogryposis, club foot with associated brain abnormalities, congenital hip dysplasia with associated brain abnormalities, and congenital sensorineural hearing loss).

§ Neural tube defects and other early brain malformations are included as biologically plausible birth defects; however, they have been reported much less frequently with Zika virus infection than have defects in the other categories.

All 15 U.S. jurisdictions¶ included in this report had existing birth defects surveillance systems that were rapidly adapted to monitor birth defects potentially related to Zika virus infection. These jurisdictions provided data on live births and pregnancy losses occurring from January 1–December 31, 2016. The jurisdictions were stratified into the following three groups: those with 1) confirmed local Zika virus transmission during 2016**; 2) one or more cases of confirmed, symptomatic, travel-associated Zika virus disease reported to CDC per 100,000 residents (i.e., "higher" Zika prevalence)††; and 3) less than one case per 100,000 residents of confirmed, symptomatic, travel-associated Zika virus disease reported to CDC (i.e., "lower" [low or no travel-associated] Zika prevalence)§§ (*3*).

Overall, 2,962 infants and fetuses with birth defects potentially related to Zika virus infection were identified (3.0 per 1,000 live births; CI = 2.9–3.2) (Table), including 1,457 (49%) with brain abnormalities or microcephaly, 581 (20%) with NTDs, 262 (9%) with eye abnormalities without mention of a brain abnormality, and 662 (22%) with other consequences of CNS dysfunction without mention of brain or eye abnormalities. Among the 2,962 infants and fetuses with defects potentially related to Zika virus infection, there were 2,716 (92%) live births. Laboratory evidence of possible Zika virus infection in maternal, placental, infant, or fetal specimens was present in 45 (1.5%) cases; 96 (3.2%) had negative tests for Zika virus, and 2,821 (95.2%) either had no testing performed or no results available.

The prevalence of reported birth defects cases potentially related to Zika virus infection increased in jurisdictions with confirmed local transmission, from 2.8 per 1,000 live births (182 cases) during the first half of 2016 to 3.0 per 1,000 live births (211 cases) during the second half (CI = 2.4-3.2 and CI = 2.6–3.4, respectively; p = 0.10). In "higher" Zika prevalence jurisdictions, the monitored birth defects prevalence was 3.0 per 1,000 live births in both the first (753 cases) and second (775 cases) halves of 2016. In "lower" prevalence jurisdictions, the monitored birth defects prevalence declined significantly from 3.4 per 1,000 live births (549 cases) during the first

¶ Participating jurisdictions included Florida (selected southern counties), Georgia (selected metropolitan Atlanta counties), Hawaii, Illinois, Iowa, Massachusetts, New Jersey, New York (excluding New York City), North Carolina (selected regions), Puerto Rico, Rhode Island, South Carolina, Texas (Public Health Regions 1, 3, 9, and 11), Utah, and Vermont.
** Jurisdictions with confirmed local Zika virus transmission during 2016 were as follows: southern Florida, Puerto Rico, and Texas Public Health Region 11.
†† Jurisdictions with one or more cases of confirmed, symptomatic, travel-associated Zika virus disease reported to CDC per 100,000 residents (i.e., "higher" prevalence) included Georgia, Massachusetts, New Jersey, New York, Rhode Island, South Carolina, Texas Public Health Regions 1, 3, and 9, and Vermont.
§§ Jurisdictions with less than one case per 100,000 residents of confirmed, symptomatic, travel-associated Zika virus disease reported to CDC (i.e., "lower" prevalence) included Hawaii, Illinois, Iowa, North Carolina, and Utah.

Summary

What is already known about this topic?

Data collected from three U.S. population-based birth defects surveillance systems from 2013 and 2014, before the introduction of Zika virus infection in the World Health Organization's Region of the Americas, showed a baseline prevalence of birth defects potentially related to congenital Zika virus infection of 2.9 per 1,000 live births. Based on 2016 data from the U.S. Zika Pregnancy and Infant Registry, the risk for birth defects potentially related to Zika virus infection in pregnancies with laboratory evidence of possible Zika virus infection was approximately 20-fold higher than the baseline prevalence.

What is added by this report?

This report provides the first comprehensive data on the prevalence of birth defects (3.0 per 1,000 live births) potentially related to Zika virus infection in a birth cohort of nearly 1 million births in 2016. A significant increase in birth defects strongly related to Zika virus during the second half of 2016 compared with the first half was observed in jurisdictions with local Zika virus transmission. Only a small percentage of birth defects potentially related to Zika had laboratory evidence of Zika virus infection, and most were not tested for Zika virus.

What are the implications for public health practice?

Whereas the U.S. Zika Pregnancy and Infant Registry monitors women with laboratory evidence of possible Zika virus infection during pregnancy and their congenitally exposed infants, population-based birth defects surveillance systems make a unique contribution by identifying and monitoring all cases of these birth defects regardless of exposure or laboratory testing or results. Continued surveillance for birth defects potentially related to Zika virus infection is important because most pregnancies affected by Zika virus ended in 2017. These data will help communities plan for needed resources to care for affected patients and families and can serve as a foundation for linking and evaluating health and developmental outcomes of affected children.

half of 2016 to 3.0 (492 cases) per 1,000 live births during the second half (CI = 3.2–3.7 and CI = 2.8–3.3, respectively; p = 0.002) (Figure 1).

When NTDs were excluded, the prevalence of birth defects potentially related to Zika virus infection in jurisdictions with local Zika transmission increased 21%, from 2.0 per 1,000 live births (CI = 1.7–2.4) to 2.4 (CI = 2.1–2.8) (Figure 2). This increase indicated there were 29 more infants and fetuses with birth defects than were expected in areas with local transmission in the second half of 2016 (169 observed cases compared with 140 expected, p = 0.009). The prevalence of birth defects excluding NTDs in "higher" prevalence jurisdictions did not change (2.4 per 1,000 live births) and the prevalence in the "lower" prevalence jurisdictions significantly decreased from 2.8 per 1,000 live births (CI = 2.5–3.0) to 2.4 (CI = 2.2-2.7). Among 393 infants and fetuses with birth defects potentially

TABLE. Population-based counts of cases of infants and fetuses with birth defects potentially related to Zika virus infection and prevalence per 1,000 live births — 15 U.S. jurisdictions,* 2016

Characteristic	Brain abnormalities or microcephaly[†] (N = 1,457; 49%)	Neural tube defects and other early brain malformations[§] (N = 581; 20%)	Eye abnormalities[¶] (N = 262; 9%)	Consequences of CNS dysfunction** (N = 662; 22%)	Total (N = 2,962; 100%)
Prevalence per 1,000 live births (95% CI)	1.5 (1.4–1.6)	0.60 (0.55–0.65)	0.27 (0.24–0.30)	0.68 (0.63–0.74)	3.0 (2.9–3.2)
Eye abnormalities No. (%)	144 (9.9)	24 (4.1)	—	0	430 (14.5)
Consequences of CNS dysfunction No. (%)	133 (9.1)	77 (13.3)	12 (4.6)	—	884 (29.8)
Pregnancy outcome[††]					
Live births No. (%)	1,387 (95.2)	427 (73.5)	257 (98.1)	645 (97.4)	2,716 (91.7)
Neonatal death (≤28 days) No.	89	92	8	30	219
Pregnancy loss[§§] No. (%)	65 (4.5)	149 (25.6)	5 (1.9)	16 (2.4)	235 (7.9)
Zika virus laboratory testing for infants or mothers					
Positive No. (%)	29 (2.0)	4 (0.69)	10 (3.8)	2 (0.30)	45 (1.5)
Negative No. (%)	65 (4.5)	20 (3.4)	3 (1.1)	8 (1.2)	96 (3.2)
No testing performed/NA[¶¶] No. (%)	1,363 (93.5)	557 (95.9)	249 (95.0)	652 (98.5)	2,821 (95.2)

Abbreviations: CI = confidence interval; CNS = central nervous system; NA = not available.

* 15 U.S. jurisdictions: Florida (selected southern counties), Georgia (selected metropolitan Atlanta counties), Hawaii, Iowa, Illinois, Massachusetts, New Jersey, New York (excluding New York City), North Carolina (selected regions), Puerto Rico, Rhode Island, South Carolina, Texas (Public Health Regions 1, 3, 9, and 11), Utah, and Vermont. Total live births = 971,685.

[†] Brain abnormalities or microcephaly (congenital microcephaly [head circumference <3rd percentile for gestational age and sex], intracranial calcifications, cerebral atrophy, abnormal cortical gyral patterns [e.g., polymicrogyria, lissencephaly, pachygyria, schizencephaly, gray matter heterotopia], corpus callosum abnormalities, cerebellar abnormalities, porencephaly, hydranencephaly, ventriculomegaly/hydrocephaly [excluding "mild" ventriculomegaly without other brain abnormalities], fetal brain disruption sequence [collapsed skull, overlapping sutures, prominent occipital bone, scalp rugae], other major brain abnormalities).

[§] Neural tube defects and other early brain malformations (anencephaly/acrania, encephalocele, spina bifida, and holoprosencephaly).

[¶] Structural eye abnormalities (microphthalmia/anophthalmia, coloboma, cataract, intraocular calcifications, and chorioretinal anomalies [e.g., atrophy and scarring, gross pigmentary changes, excluding retinopathy of prematurity]); optic nerve atrophy, pallor, and other optic nerve abnormalities.

** Consequences of CNS dysfunction (arthrogryposis, club foot with associated brain abnormalities, congenital hip dysplasia with associated brain abnormalities, and congenital sensorineural hearing loss).

[††] 11 unknown pregnancy outcomes not included.

[§§] Includes miscarriages, fetal deaths, and terminations.

[¶¶] Includes cases linked to lab data where no testing was performed or there was unknown testing status.

related to Zika virus infection in areas with local transmission, 32 (8.1%) had laboratory evidence of possible Zika virus infection in a maternal, placental, infant, or fetal sample, 59 (15.0%) had negative Zika virus test results, and 302 (76.81%) had no testing performed or no results available.

Discussion

Leveraging existing birth defects surveillance systems permitted rapid implementation of surveillance for birth defects potentially related to Zika virus infection early during the U.S. Zika virus outbreak. The prevalence of birth defects strongly linked to Zika virus infection increased significantly in areas with local Zika virus transmission (29 more than were expected in the second half of 2016 compared with observed prevalence in the first half). This finding underscores the importance of surveillance for birth defects potentially related to Zika virus infection and the need for continued monitoring in areas at risk for Zika transmission and exposure.

An increase in birth defects potentially related to Zika was only observed in jurisdictions with local Zika virus transmission, and this difference was significant when NTDs were excluded. Brain and eye abnormalities and consequences of CNS dysfunction have been most consistently described in

cases of congenital Zika infection, whereas the evidence supporting a possible association between NTDs and Zika virus infection during pregnancy is weak (1,2). In jurisdictions with "lower" (low or no travel-associated) Zika prevalence, the reason for the significant decrease in prevalence of birth defects potentially related to Zika (both including NTDs and excluding NTDs) is not clear. However, birth defects surveillance data typically are not final until approximately 24 months after the end of the birth year, and this release of data only 12 months after the end of the birth year likely resulted in less complete ascertainment of birth defects in late 2016 compared with early 2016. Further case ascertainment from the final quarter of 2016 is anticipated in all jurisdictions. In addition, the peak occurrence of birth defects potentially related to Zika virus infection is expected to have occurred in the 2017 birth cohort because the peak of Zika virus transmission occurred in Puerto Rico in August 2016, and local transmission of Zika virus was identified in southern Florida in June 2016 and in southern Texas in November 2016 (4–7).

The overall prevalence of the birth defects in this analysis (3.0 per 1,000 live births) was similar to a previously published baseline prevalence of birth defects potentially related to Zika virus infection from 2013–14 (2.9 per 1,000 live births;

FIGURE 1. Prevalence of birth defects cases potentially related to Zika virus infection, by Zika virus transmission characteristics and quarter — 15 U.S. jurisdictions, 2016*,†,§
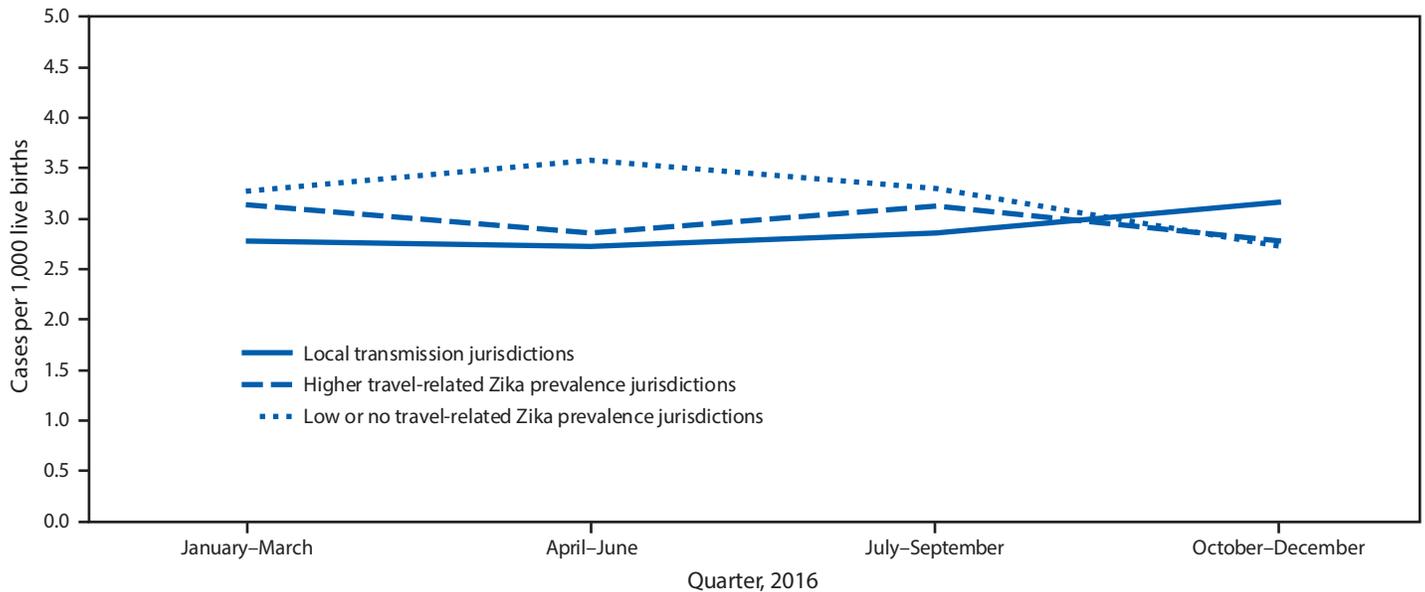
* Local transmission jurisdictions included Florida (selected southern counties), Puerto Rico, and Texas (Public Health Region 11).
† Higher travel-related Zika prevalence jurisdictions had one or more case of confirmed symptomatic travel-associated Zika virus disease reported to CDC per 100,000 residents. These jurisdictions included Georgia (selected metropolitan Atlanta counties), Massachusetts, New Jersey, New York (excluding New York City), Rhode Island, South Carolina, Texas (Public Health Regions 1, 3, and 9), and Vermont.
§ Low or no travel-related Zika prevalence jurisdictions had less than one case of confirmed symptomatic travel-associated Zika virus disease reported to CDC per 100,000 residents. These jurisdictions included Hawaii, Illinois, Iowa, North Carolina (selected regions), and Utah.

95% CI = 2.7–3.1) (8). The findings presented here included data from an additional 12 jurisdictions, which covers a larger birth cohort totaling nearly 1 million live births, representing approximately one fourth of the total live births in the U.S. states and territories.

The findings in this report are subject to at least three limitations. First, the three jurisdictions with local Zika virus transmission differed from one another in the scope and timing of identified local transmission of Zika virus. Whereas Puerto Rico experienced a widespread outbreak that began in early 2016, local transmission in Texas was not confirmed until November 2016. In addition, jurisdictions with local transmission also had a high prevalence of travel-related Zika virus disease in 2016 (3), which could have contributed to the observed increased prevalence in birth defects. Second, increased awareness of birth defects potentially related to Zika virus infection in areas with local transmission might have resulted in increased efforts focused on rapid and complete identification of these birth defects cases during the second half of 2016. However, a significant increase in NTD prevalence was not observed. Although more complete ascertainment might partially explain the increased prevalence observed in areas with local transmission, it is unlikely that it would lead to a significant change, given the longstanding, mature surveillance systems, the

standardized case review process, and no observable change in the prevalence of NTDs. Finally, jurisdictions in this analysis might differ in population demographics and systematic case-finding methodology, contributing to differences in observed prevalences among the three groups (9). A comparison of the prevalences in the first and second halves of the year was used to partially control for regional differences and monitor trends for those specific jurisdictional groups rather than to compare one group with another.

Collaboration between state and territorial Zika pregnancy and infant registries and birth defects surveillance systems provides a model for using the complementary approach of a prospective, exposure-based surveillance and conventional disease-based surveillance to respond to an emerging public health threat. The U.S. Zika Pregnancy and Infant Registry¶ can provide an early alert mechanism regarding clinical characteristics and manifestations of infants and fetuses with potential congenital infection; over 7,000 pregnancies with laboratory evidence of Zika virus infection have been reported, and CDC

¶ The U.S. Zika Pregnancy and Infant Registry includes the U.S. Zika Pregnancy Registry and the Zika Active Pregnancy Surveillance System, which together collect information about pregnancy and infant outcomes among women with laboratory evidence of Zika virus infection during pregnancy in the 50 states, the District of Columbia, and U.S. territories, until at least 2 years of age. (https://www.cdc.gov/pregnancy/zika/research/registry.html).

FIGURE 2. Prevalence of birth defects cases* potentially related to Zika virus infection in U.S. jurisdictions with documented local transmission of Zika virus,[†] by defect type and quarter, 2016
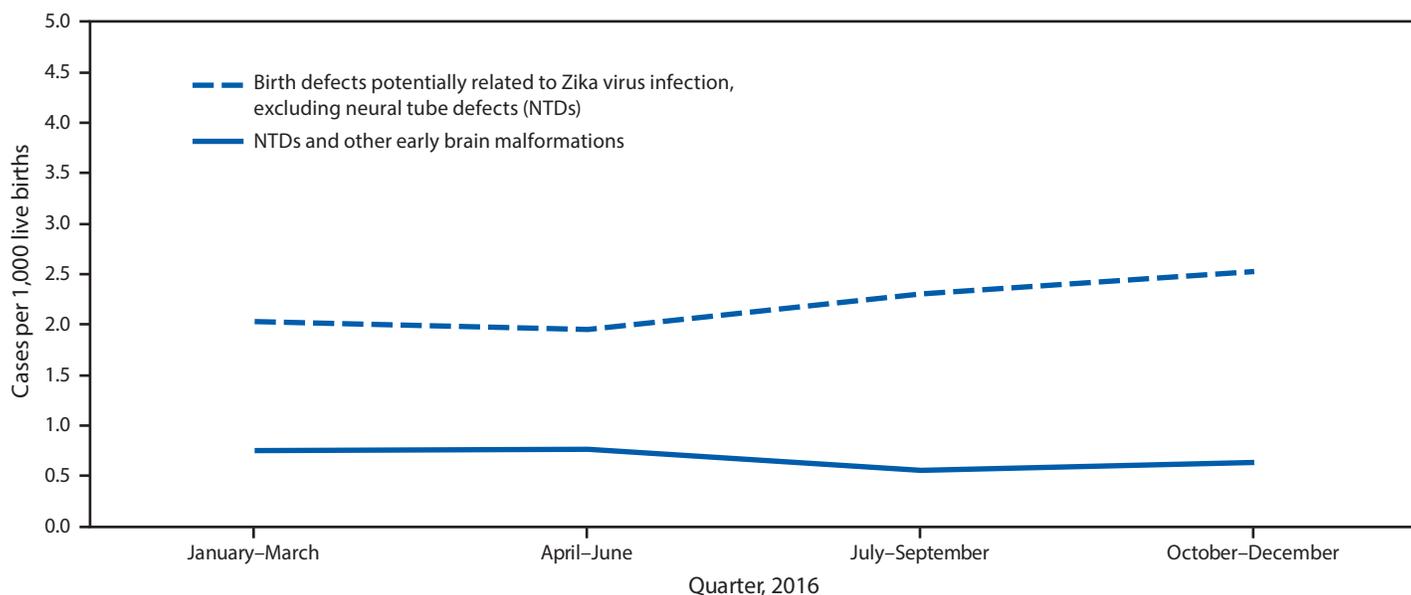
* Fetuses and infants were aggregated into the following four mutually exclusive categories: those with 1) brain abnormalities with or without microcephaly (head circumference at delivery <3rd percentile for sex and gestational age); 2) NTDs and other early brain malformations; 3) eye abnormalities among those without mention of a brain abnormality included in the first two categories; and 4) other consequences of central nervous system dysfunction, specifically joint contractures and congenital sensorineural deafness, among those without mention of brain or eye abnormalities included in another category.
[†] Jurisdictions with local transmission of Zika virus included Florida (selected southern counties), Puerto Rico, and Texas (Public Health Region 11).

is monitoring pregnancy and infant adverse outcomes (https://www.cdc.gov/pregnancy/zika/data/pregnancy-outcomes.html). Established birth defects surveillance systems can adapt to monitor other emerging pregnancy, infant, and newborn outcomes of concern beyond structural birth defects, including functional problems such as hearing loss, and can provide additional clinical information through standardized data collection and clinical review. Finally, birth defects surveillance systems can provide an important mechanism for facilitating timely access to services among infants with birth defects and serve as a resource for assessing subsequent health and developmental outcomes among these children. The unique contributions of ongoing birth defects surveillance and the U.S. Zika Pregnancy and Infant Registry are both critical to optimally monitoring pregnant women and infants from the threat of Zika virus infection and implementing appropriate prevention efforts (*10*).

Conflict of Interest

No conflicts of interest were reported.

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State-Specific Prevalence of Tobacco Product Use Among Adults — United States, 2014–2015

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Despite recent declines in cigarette smoking prevalence, the tobacco product landscape has shifted to include emerging tobacco products* (1,2). Previous research has documented adult use of smokeless tobacco and cigarettes by state (3); however, state-specific data on other tobacco products are limited. To assess tobacco product use in the 50 U.S. states and the District of Columbia (DC), CDC and the National Cancer Institute analyzed self-reported use of six tobacco product types: cigarettes, cigars, regular pipes, water pipes, electronic cigarettes (e-cigarettes), and smokeless tobacco products among adults aged ≥18 years using data from the 2014–2015 Tobacco Use Supplement to the Current Population Survey (TUS-CPS). Prevalence of ever-use of any tobacco product ranged from 27.0% (Utah) to 55.4% (Wyoming). Current (every day or some days) use of any tobacco product ranged from 10.2% (California) to 27.7% (Wyoming). Cigarettes were the most common currently used tobacco product in all states and DC. Among current cigarette smokers, the proportion who currently used one or more other tobacco products ranged from 11.5% (Delaware) to 32.3% (Oregon). Differences in tobacco product use across states underscore the importance of implementing proven population-level strategies to reduce tobacco use and expanding these strategies to cover all forms of tobacco marketed in the United States. Such strategies could include comprehensive smoke-free policies, tobacco product price increases, anti-tobacco mass media campaigns, and barrier-free access to clinical smoking cessation resources (1,4).

The 2014–15 TUS-CPS was a household-based survey of adults aged ≥18 years in the 50 U.S. states and DC (5). A total of 163,920 respondents participated (response rate = 54.2%).†

Six tobacco product types were assessed: cigarettes, cigars (including regular cigars, cigarillos, or little filtered cigars), regular pipes, water pipes, e-cigarettes, and smokeless tobacco products (including moist snuff, dip, spit, chew tobacco, snus, or dissolvable tobacco).

For all tobacco product types except cigarettes,§ ever-users were defined as persons who had used the respective products one or more times during their lifetime; current users were persons who reported ever-use and who used the respective products "every day" or "some days" at the time of survey. Ever cigarette smokers were defined as persons who had smoked 100 or more cigarettes during their lifetime; current cigarette smokers were persons who reported ever cigarette smoking and smoked "every day" or "some days" at the time of survey. Any tobacco product use was defined as use of any of the six assessed tobacco products,¶ and any combustible tobacco product use was defined as any use of cigarettes, cigars, regular pipes, or water pipes.** Data were weighted to yield state-representative estimates. Prevalence estimates with relative standard errors ≥30% were suppressed.

Prevalence of ever-use ranged from 27.0% (Utah) to 55.4% (Wyoming) for any tobacco product, from 25.8% (Utah) to 53.2% (Maine) for any combustible tobacco product, from 22.0% (Utah) to 44.3% (Maine) for cigarettes, from 10.6% (Utah) to 26.3% (Oregon) for cigars, from 4.3% (Delaware) to 14.2% (Wyoming) for e-cigarettes, from 2.7% (New Jersey) to 20.5% (Wyoming) for smokeless tobacco, from 3.2% (New Jersey) to 12.0% (Oregon) for regular pipes, and from 1.5% (Arkansas) to 16.7% (DC) for water pipes (Table 1).

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* Emerging tobacco products are noncigarette tobacco products that have gained increasing popularity and use within the U.S. market over the past decade.

† Tobacco Use Supplement to the Current Population Survey (TUS-CPS) is conducted in person or by proxy. The 2014–2015 survey was co-sponsored by the National Cancer Institute and the Food and Drug Administration Center for Tobacco Products and was administered as part of the U.S. Census Bureau's Current Population Survey of the civilian, noninstitutionalized U.S. population. For the 2014–2015 iteration of the survey, 163,920 responses were self-reported (54,125 from July 2014, 56,652 from January 2015, and 53,143 from May 2015), and 67,476 were proxy-reported. Sensitivity analyses showed systematic differences between self- and proxy-responses in relation to key demographic characteristics, especially for younger adults. To reduce likelihood of misclassification bias, proxy responses were excluded from these analyses. The TUS-CPS self-response weights derived by the Census Bureau count proxy respondents as "nonrespondents" when an analysis is conducted only with self-respondents. https://cancercontrol.cancer.gov/brp/tcrb/tus-cps/.

§ The following smokeless tobacco products were combined together and analyzed as a class of products: moist snuff, dip, spit, chew tobacco, snus, or dissolvable tobacco. Use of smokeless tobacco product was assessed with separate questions: "Have you ever used any of the following even one time? Smokeless tobacco, such as moist snuff, dip, spit, chew tobacco or snus," "Have you ever used dissolvable tobacco even one time?" and whether the respondent used the respective product "every day" or "some days" at the time of survey. Participants who had at least one missing response to these questions were excluded from the analysis (1.4% [2,356] of respondents for ever-use; 1.4% [2,373] of respondents for current use).

¶ Participants who had at least one missing response to any of the assessed tobacco product type questions were excluded from the analysis (1.7% [2,734] of respondents for ever-use; 1.8% [2,875] of respondents for current use).

** Participants who had at least one missing response to any of the combustible tobacco product type questions were excluded from the analysis (1.5% [2,489] of respondents for ever-use; 1.6% [2,645] of respondents for current use).

TABLE 1. Prevalence of ever-use of any tobacco product, combustible tobacco, and six tobacco products types among U.S. adults aged ≥18 years,* by state and tobacco product type — Tobacco Use Supplement to the Current Population Survey, United States, 2014–2015

State	Any tobacco[†] % (95% CI)	Combustible tobacco[§] % (95% CI)	Cigarettes[¶] % (95% CI)	Cigars** % (95% CI)	Regular pipe** % (95% CI)	Water pipe** % (95% CI)	Electronic cigarette** % (95% CI)	Smokeless tobacco** % (95% CI)
Alabama	41.8 (39.6–43.9)	39.3 (37.2–41.4)	34.3 (32.3–36.3)	15.3 (13.7–16.9)	5.6 (4.6–6.6)	2.0 (1.3–2.7)	10.8 (9.3–12.2)	9.8 (8.4–11.3)
Alaska	51.5 (49.0–54.0)	49.1 (46.6–51.6)	39.2 (36.8–41.6)	24.3 (22.2–26.4)	9.1 (7.7–10.5)	6.6 (5.3–7.8)	11.7 (10.0–13.4)	15.0 (13.3–16.8)
Arizona	39.5 (37.4–41.7)	38.5 (36.4–40.7)	30.2 (28.3–32.2)	17.9 (16.1–19.6)	6.7 (5.7–7.8)	6.1 (5.0–7.3)	9.5 (8.1–10.9)	5.8 (4.8–6.8)
Arkansas	47.3 (45.1–49.4)	44.4 (42.2–46.5)	41.3 (39.2–43.4)	14.8 (13.3–16.3)	5.4 (4.5–6.3)	1.5 (0.9–2.0)	9.3 (8.1–10.6)	12.0 (10.5–13.4)
California	33.3 (32.4–34.2)	32.6 (31.8–33.5)	23.9 (23.1–24.6)	15.2 (14.5–15.8)	4.5 (4.1–4.9)	6.3 (5.8–6.8)	6.1 (5.7–6.6)	4.2 (3.8–4.6)
Colorado	49.4 (47.2–51.6)	47.7 (45.5–49.9)	35.8 (33.7–37.9)	24.2 (22.3–26.1)	8.3 (7.1–9.5)	7.6 (6.4–8.9)	9.9 (8.5–11.3)	13.1 (11.6–14.6)
Connecticut	43.5 (41.1–45.8)	42.6 (40.3–45.0)	35.6 (33.4–37.8)	18.7 (16.9–20.5)	6.1 (5.1–7.2)	4.7 (3.7–5.8)	6.9 (5.6–8.2)	4.8 (3.8–5.9)
Delaware	37.2 (35.1–39.4)	36.5 (34.4–38.7)	31.8 (29.8–33.8)	11.8 (10.4–13.3)	4.3 (3.4–5.2)	2.5 (1.7–3.2)	4.3 (3.3–5.2)	3.3 (2.5–4.1)
District of Columbia	46.9 (45.0–48.9)	46.3 (44.4–48.2)	28.6 (27.0–30.3)	22.5 (20.9–24.1)	5.7 (4.8–6.5)	16.7 (15.3–18.2)	7.6 (6.6–8.6)	4.9 (4.1–5.7)
Florida	34.9 (33.7–36.1)	34.2 (33.0–35.5)	30.2 (29.0–31.3)	12.0 (11.2–12.9)	3.8 (3.3–4.3)	3.0 (2.5–3.5)	5.8 (5.2–6.5)	3.4 (3.0–3.9)
Georgia	36.9 (35.2–38.6)	35.3 (33.6–37.0)	29.5 (27.9–31.1)	14.9 (13.6–16.1)	4.8 (4.0–5.5)	3.5 (2.8–4.2)	7.8 (6.8–8.8)	7.6 (6.6–8.5)
Hawaii	33.3 (31.0–35.5)	31.5 (29.3–33.7)	26.8 (24.7–28.9)	13.7 (12.0–15.3)	4.7 (3.7–5.7)	3.5 (2.5–4.4)	9.1 (7.5–10.6)	5.2 (4.1–6.2)
Idaho	42.5 (40.3–44.6)	41.3 (39.2–43.4)	32.3 (30.3–34.3)	21.0 (19.2–22.8)	7.5 (6.3–8.6)	5.5 (4.4–6.6)	10.3 (8.9–11.6)	10.5 (9.2–11.8)
Illinois	42.0 (40.5–43.5)	41.1 (39.6–42.6)	32.6 (31.2–34.0)	17.9 (16.8–19.1)	5.3 (4.7–6.0)	4.8 (4.1–5.6)	8.3 (7.4–9.1)	6.4 (5.6–7.1)
Indiana	49.7 (47.7–51.8)	48.5 (46.5–50.6)	40.2 (38.2–42.2)	21.4 (19.7–23.0)	7.1 (6.1–8.1)	4.7 (3.7–5.7)	10.6 (9.3–12.0)	9.2 (8.0–10.4)
Iowa	51.8 (49.6–54.0)	49.2 (46.9–51.4)	39.0 (36.9–41.2)	24.9 (22.9–26.8)	8.9 (7.6–10.2)	4.7 (3.7–5.8)	10.5 (9.0–11.9)	13.7 (12.2–15.3)
Kansas	46.3 (44.1–48.4)	44.1 (42.0–46.2)	35.3 (33.3–37.4)	21.0 (19.2–22.7)	7.1 (6.0–8.1)	5.3 (4.2–6.3)	12.3 (10.8–13.8)	11.2 (9.8–12.6)
Kentucky	49.4 (47.2–51.6)	47.3 (45.2–49.4)	41.8 (39.7–43.9)	17.5 (15.8–19.1)	6.6 (5.6–7.7)	3.1 (2.2–4.0)	11.0 (9.6–12.4)	11.3 (9.9–12.7)
Louisiana	38.5 (36.6–40.5)	36.9 (34.9–38.8)	32.7 (30.8–34.5)	12.2 (10.9–13.6)	4.1 (3.3–4.9)	2.1 (1.5–2.7)	8.3 (7.2–9.5)	6.9 (5.9–8.0)
Maine	54.1 (51.8–56.4)	53.2 (51.0–55.5)	44.3 (42.0–46.5)	23.9 (22.0–25.9)	10.8 (9.5–12.2)	4.7 (3.6–5.8)	9.7 (8.3–11.2)	8.3 (7.0–9.7)
Maryland	38.7 (36.7–40.7)	38.3 (36.3–40.3)	28.6 (26.7–30.4)	17.1 (15.6–18.7)	6.0 (5.0–7.0)	5.6 (4.6–6.7)	7.1 (6.0–8.3)	3.7 (2.9–4.5)
Massachusetts	41.9 (40.0–43.9)	41.4 (39.4–43.4)	32.5 (30.7–34.3)	17.4 (15.8–18.9)	5.5 (4.6–6.4)	6.2 (5.1–7.3)	6.6 (5.5–7.7)	3.4 (2.6–4.1)
Michigan	48.3 (46.6–50.0)	47.4 (45.7–49.1)	38.3 (36.7–39.9)	20.7 (19.3–22.1)	7.8 (6.9–8.7)	6.2 (5.3–7.2)	10.8 (9.6–11.9)	8.0 (7.0–8.9)
Minnesota	50.0 (48.0–51.9)	48.3 (46.4–50.3)	37.2 (35.3–39.0)	22.6 (20.9–24.2)	8.3 (7.2–9.3)	5.2 (4.3–6.2)	9.9 (8.7–11.1)	11.4 (10.2–12.7)
Mississippi	39.9 (37.9–41.9)	37.1 (35.1–39.0)	32.9 (31.0–34.8)	12.7 (11.3–14.0)	3.9 (3.1–4.6)	1.9 (1.3–2.4)	8.1 (7.0–9.3)	10.1 (8.8–11.4)
Missouri	49.0 (46.9–51.1)	47.2 (45.1–49.3)	39.3 (37.3–41.3)	20.5 (18.8–22.2)	7.3 (6.3–8.4)	4.0 (3.1–5.0)	9.9 (8.6–11.2)	9.8 (8.5–11.1)
Montana	50.7 (48.6–52.8)	47.9 (45.8–50.0)	36.5 (34.5–38.5)	24.2 (22.3–26.0)	10.2 (8.9–11.5)	5.6 (4.4–6.7)	9.6 (8.2–10.9)	16.0 (14.4–17.6)
Nebraska	46.9 (44.7–49.2)	45.0 (42.7–47.2)	36.3 (34.2–38.5)	21.1 (19.3–23.0)	6.2 (5.1–7.3)	4.4 (3.3–5.4)	11.8 (10.3–13.4)	10.5 (9.1–12.0)
Nevada	38.0 (35.8–40.2)	37.3 (35.2–39.5)	30.8 (28.8–32.8)	13.6 (12.1–15.1)	4.4 (3.6–5.3)	6.9 (5.6–8.1)	9.1 (7.7–10.4)	4.6 (3.6–5.5)
New Hampshire	49.6 (47.5–51.6)	49.0 (47.0–51.1)	41.5 (39.5–43.5)	20.0 (18.4–21.7)	7.7 (6.7–8.8)	4.6 (3.6–5.6)	7.8 (6.6–8.9)	6.5 (5.4–7.6)
New Jersey	34.1 (32.3–35.9)	33.8 (32.0–35.6)	28.9 (27.2–30.6)	11.4 (10.2–12.6)	3.2 (2.5–3.8)	2.6 (1.9–3.2)	5.1 (4.2–6.0)	2.7 (2.1–3.3)
New Mexico	38.8 (36.6–41.0)	37.6 (35.4–39.7)	31.3 (29.2–33.3)	14.8 (13.2–16.4)	4.5 (3.7–5.4)	3.5 (2.6–4.3)	7.3 (6.2–8.5)	5.9 (4.9–7.0)
New York	38.2 (36.8–39.5)	37.6 (36.3–39.0)	31.0 (29.8–32.2)	14.3 (13.4–15.3)	4.4 (3.9–4.9)	4.7 (4.1–5.4)	7.3 (6.6–8.1)	3.9 (3.3–4.4)
North Carolina	43.9 (42.1–45.7)	41.5 (39.7–43.3)	34.5 (32.8–36.2)	16.3 (14.8–17.7)	6.1 (5.2–7.1)	4.4 (3.6–5.3)	8.9 (7.8–10.1)	8.2 (7.1–9.2)
North Dakota	51.3 (49.1–53.5)	48.2 (45.9–50.4)	39.1 (36.9–41.2)	23.3 (21.4–25.2)	8.1 (6.9–9.4)	5.4 (4.2–6.5)	9.7 (8.4–11.1)	17.5 (15.7–19.2)
Ohio	50.2 (48.6–51.8)	48.7 (47.1–50.2)	39.6 (38.1–41.1)	22.2 (20.9–23.5)	7.3 (6.6–8.1)	4.5 (3.7–5.3)	11.2 (10.1–12.2)	9.6 (8.6–10.6)
Oklahoma	46.1 (44.0–48.2)	44.1 (42.0–46.3)	38.6 (36.5–40.7)	17.3 (15.7–19.0)	5.6 (4.7–6.5)	2.7 (2.0–3.5)	12.0 (10.6–13.4)	12.0 (10.6–13.4)
Oregon	49.7 (47.6–51.9)	48.3 (46.2–50.5)	37.6 (35.6–39.7)	26.3 (24.3–28.2)	12.0 (10.5–13.4)	6.4 (5.3–7.6)	10.1 (8.7–11.5)	11.7 (10.3–13.2)
Pennsylvania	48.4 (46.8–50.0)	46.9 (45.3–48.5)	38.5 (37.0–39.9)	20.5 (19.3–21.8)	7.1 (6.4–7.9)	4.2 (3.5–4.9)	9.1 (8.2–10.1)	9.1 (8.2–10.0)
Rhode Island	41.5 (39.0–44.0)	41.1 (38.6–43.5)	34.1 (31.8–36.4)	16.0 (14.1–17.8)	5.8 (4.7–6.8)	5.4 (4.0–6.7)	6.2 (4.9–7.5)	3.6 (2.6–4.6)
South Carolina	41.7 (39.7–43.8)	40.4 (38.4–42.4)	34.8 (32.9–36.7)	16.2 (14.7–17.8)	6.5 (5.4–7.5)	3.2 (2.4–4.0)	8.4 (7.2–9.6)	7.0 (6.0–8.0)
South Dakota	53.0 (50.7–55.3)	50.0 (47.7–52.3)	41.5 (39.2–43.8)	23.4 (21.4–25.4)	7.3 (6.1–8.4)	5.7 (4.5–6.9)	11.3 (9.7–12.8)	15.1 (13.4–16.8)
Tennessee	45.0 (43.0–47.0)	43.0 (41.1–45.0)	36.5 (34.6–38.4)	17.6 (16.1–19.1)	7.0 (6.0–7.9)	3.3 (2.6–4.1)	10.7 (9.4–11.9)	10.0 (8.8–11.1)
Texas	37.5 (36.3–38.6)	35.6 (34.5–36.7)	28.2 (27.2–29.2)	14.9 (14.1–15.7)	5.0 (4.5–5.5)	4.7 (4.1–5.2)	8.3 (7.6–8.9)	7.2 (6.6–7.8)
Utah	27.0 (25.0–29.0)	25.8 (23.8–27.8)	22.0 (20.1–23.9)	10.6 (9.2–12.1)	4.3 (3.4–5.3)	5.0 (3.9–6.0)	8.8 (7.4–10.1)	5.6 (4.6–6.7)
Vermont	52.6 (50.6–54.7)	51.7 (49.7–53.8)	42.8 (40.7–44.8)	21.9 (20.2–23.7)	11.1 (9.7–12.4)	5.1 (4.0–6.1)	8.7 (7.4–10.0)	8.7 (7.4–9.9)
Virginia	43.9 (42.1–45.7)	42.8 (41.0–44.7)	32.7 (31.0–34.4)	18.7 (17.3–20.1)	6.5 (5.6–7.4)	6.9 (5.9–7.9)	8.9 (7.8–10.0)	7.9 (6.9–8.9)
Washington	47.7 (45.8–49.6)	46.3 (44.4–48.2)	35.4 (33.7–37.2)	24.7 (23.0–26.3)	9.3 (8.2–10.4)	6.7 (5.7–7.7)	10.8 (9.6–12.0)	10.5 (9.4–11.7)
West Virginia	50.2 (48.1–52.3)	46.5 (44.4–48.6)	40.4 (38.3–42.4)	17.9 (16.1–19.6)	7.2 (6.0–8.3)	2.5 (1.7–3.3)	10.3 (9.0–11.7)	14.5 (12.9–16.1)
Wisconsin	50.2 (48.2–52.2)	48.9 (46.9–51.0)	37.8 (35.9–39.7)	24.4 (22.6–26.1)	7.5 (6.4–8.6)	4.3 (3.4–5.3)	9.2 (8.0–10.4)	10.0 (8.8–11.3)
Wyoming	55.4 (53.2–57.6)	51.3 (49.2–53.5)	40.6 (38.5–42.8)	23.9 (22.0–25.8)	9.9 (8.5–11.3)	6.9 (5.5–8.3)	14.2 (12.6–15.8)	20.5 (18.7–22.4)

Abbreviation: CI = confidence interval.

* n = 163,920. Data were weighted to adjust for nonresponse and to yield representative estimates at the state level.

† Persons who reported ever use of at least one of the six tobacco products assessed (cigarette, cigar, regular pipe, water pipe, e-cigarette, and smokeless tobacco).

§ Persons who reported having used cigarette, cigar, regular pipe, or water pipe at least once during their lifetime.

¶ Persons who reported having smoked ≥100 cigarettes during their lifetime.

** Persons who reported having used the respective product at least once during their lifetime. Cigars include cigarillos and little cigars. Smokeless tobacco includes moist snuff, dip, spit, chew tobacco, snus, and dissolvable tobacco.

In all states, cigarettes were the most commonly ever-used tobacco products, followed by cigars. The third most commonly reported ever-used product was e-cigarettes in 32 states (range for those states = 5.1% in New Jersey to 11.8% in Nebraska); smokeless tobacco in 14 states (9.1% in Pennsylvania to 20.5% in Wyoming); regular pipes in Delaware (4.3%), Maine (10.8%), and Vermont (11.1%); and water pipes in California (6.3%) and DC (16.7%).

Prevalence of current use of any tobacco product ranged from 10.2% (California) to 27.7% (Wyoming) (Table 2). Among respondents who had ever used any tobacco product, the proportion who were current users of any tobacco product ranged from 30.7% (California) to 57.7% (Mississippi) (not presented in Tables). Current use of any combustible tobacco product ranged from 8.9% (Utah) to 23.1% (West Virginia). Among respondents who had ever used any combustible tobacco product, the proportion who were current combustible tobacco product users ranged from 28.6% (California) to 53.0% (Mississippi). Current cigarette smoking prevalence ranged from 8.0% (Utah) to 21.7% (West Virginia); among ever cigarette smokers, the proportion who were current cigarette smokers ranged from 33.9% (California) to 57.3% (Louisiana). Prevalence of current cigar use ranged from 1.0% (Utah) to 3.5% (Alaska); among respondents who had ever smoked cigars, the proportion who were current cigar smokers ranged from 8.1% (Vermont) to 20.0% (New Jersey). The prevalence of current e-cigarette use ranged from 1.3% (Delaware) to 4.4% (Wyoming); among e-cigarette ever-users, the proportion who were current e-cigarette users ranged from 16.6% (DC) to 40.0% (Rhode Island). The prevalence of current smokeless tobacco use ranged from 0.6% (New York) to 6.4% (Wyoming); among respondents who had ever used smokeless tobacco, the proportion who were current smokeless tobacco users ranged from 6.7% (Maine) to 36.1% (Mississippi). The prevalence of current water pipe smoking prevalence ranged from 0.4% (Florida) to 1.9% (DC); among respondents who had ever smoked water pipes, the proportion who were current water pipe smokers ranged from 0.0% (Arkansas) and Oklahoma to 21.2% (Rhode Island). Finally, the prevalence of current regular pipe smoking ranged from 0.2% (Florida), to 1.0% (Oregon); among those who had ever smoked a regular pipe, the proportion who were current regular pipe smokers ranged from 2.9% (Georgia) to 13.0% (Utah).

Cigarettes were the most common currently used tobacco product in all states and DC. The second most common currently used product in 23 states was e-cigarettes (range = 1.8% in Vermont to 3.9% in Idaho), cigars in 18 states and DC (1.7% in California to 3.5% in Alaska), and smokeless tobacco in nine states (3.6% in Mississippi to 6.4% in Wyoming).

Among persons reporting current use of any tobacco product, the proportion reporting concurrent use of two or more tobacco products ranged from 11.5% (Delaware) to 27.0% (Oregon). The proportion of current cigarette smokers reporting concurrent use of a noncigarette tobacco product ranged from 11.5% (Delaware) to 32.3% (Oregon) (Figure).

Discussion

Ever-use of any tobacco product by adults aged ≥18 years ranged from 27.0% (Utah) to 55.4% (Wyoming), and current use ranged from 10.2% (California) to 27.7% (Wyoming); nine of the 10 states with the highest prevalence of current use of any tobacco product were in the Midwest or South, and seven of the 10 states with the lowest prevalence were in the Northeast or West. Apart from regional and demographic characteristics, the differences across states in tobacco use might, in part, reflect differences in tobacco control and prevention interventions. For example, eight of the 10 states with the lowest prevalence of current use of any tobacco product have implemented policies that prohibit smoking in all indoor areas of workplaces, bars, and restaurants. In contrast, seven of the 10 states with the highest prevalence have no such comprehensive smoke-free laws.[††] Continued implementation of proven population-based interventions, including increasing tobacco product prices, implementing and enforcing comprehensive smoke-free laws, warning about the dangers of tobacco use, and increasing barrier-free access to cessation services, can help reduce tobacco use (1,4).

Cigarettes were the most commonly used tobacco product, and nearly one in five current cigarette smokers concurrently used another form of tobacco. Among ever-users of each of the six tobacco products assessed, the proportion of current users was highest for cigarettes, followed by e-cigarettes. Given that most tobacco initiation occurs in adolescence and young adulthood (6), and product trial is a critical step in initiating and maintaining tobacco use (7), intensified efforts to prevent experimentation could reduce the likelihood of a lifetime of tobacco addiction. In light of the ever-changing tobacco control landscape, it is important to expand surveillance, policy, and programs to cover the range of tobacco products being marketed and used among youth and adults (4). For example, eight U.S. states and DC have expanded their comprehensive smoke-free laws to include e-cigarettes (8), and California and several U.S. cities have enacted policies prohibiting smokeless tobacco use in public sport arenas, which include 14 of 30 major league baseball stadiums.[§§]

[††] https://www.cdc.gov/mmwr/volumes/65/wr/mm6524a4.htm.
[§§] http://tobaccofreebaseball.org/news-coverage/.

TABLE 2. Prevalence of current use of any tobacco product, combustible tobacco, and six tobacco products types among adults aged ≥18 years,* by state and tobacco product type — Tobacco Use Supplement to the Current Population Survey, United States, 2014–2015

State	Any tobacco[†] % (95% CI)	Combustible tobacco[§] % (95% CI)	Cigarettes[¶] % (95% CI)	Cigars** % (95% CI)	Regular pipe** % (95% CI)	Water pipe** % (95% CI)	Electronic cigarette** % (95% CI)	Smokeless tobacco** % (95% CI)
Alabama	23.1 (21.2–24.9)	19.7 (17.9–21.5)	18.2 (16.5–19.9)	2.9 (2.2–3.7)	—[††]	—[††]	3.8 (3.0–4.6)	3.3 (2.5–4.0)
Alaska	21.4 (19.4–23.5)	18.5 (16.5–20.4)	16.2 (14.3–18.0)	3.5 (2.5–4.5)	—[††]	—[††]	2.4 (1.7–3.2)	3.5 (2.5–4.4)
Arizona	14.4 (12.9–15.9)	13.0 (11.5–14.5)	11.9 (10.5–13.3)	1.5 (0.9–2.0)	—[††]	1.1 (0.5–1.6)	2.4 (1.7–3.1)	0.9 (0.5–1.4)
Arkansas	24.0 (22.2–25.8)	20.4 (18.7–22.1)	20.0 (18.3–21.7)	1.9 (1.3–2.5)	—[††]	—[††]	2.8 (2.0–3.5)	4.0 (3.1–4.8)
California	10.2 (9.6–10.8)	9.4 (8.8–9.9)	8.0 (7.5–8.5)	1.7 (1.4–1.9)	0.2 (0.1–0.3)	0.6 (0.5–0.8)	1.4 (1.1–1.6)	0.6 (0.4–0.8)
Colorado	16.9 (15.2–18.6)	14.9 (13.3–16.5)	13.1 (11.6–14.6)	2.1 (1.5–2.7)	—[††]	0.8 (0.3–1.3)	2.6 (1.8–3.3)	1.8 (1.2–2.3)
Connecticut	15.4 (13.7–17.1)	14.3 (12.7–16.0)	12.3 (10.8–13.9)	3.0 (2.1–3.8)	—[††]	—[††]	2.3 (1.6–3.0)	—[††]
Delaware	15.2 (13.6–16.8)	14.3 (12.8–15.9)	13.3 (11.8–14.8)	1.9 (1.2–2.5)	—[††]	—[††]	1.3 (0.8–1.8)	—[††]
District of Columbia	15.8 (14.4–17.3)	15.5 (14.1–16.9)	12.2 (10.9–13.4)	3.0 (2.3–3.7)	0.5 (0.2–0.8)	1.9 (1.3–2.5)	1.3 (0.9–1.7)	—[††]
Florida	14.4 (13.5–15.3)	13.2 (12.3–14.1)	12.1 (11.3–13.0)	2.1 (1.7–2.5)	0.2 (0.1–0.3)	0.4 (0.2–0.5)	1.8 (1.5–2.2)	0.8 (0.6–1.0)
Georgia	16.8 (15.5–18.2)	14.7 (13.4–15.9)	13.4 (12.2–14.7)	2.1 (1.5–2.6)	—[††]	0.5 (0.3–0.8)	2.5 (1.9–3.0)	1.9 (1.4–2.4)
Hawaii	13.9 (12.2–15.6)	11.7 (10.1–13.2)	10.5 (9.0–12.0)	1.6 (1.0–2.1)	—[††]	—[††]	2.8 (1.9–3.6)	0.9 (0.5–1.4)
Idaho	17.4 (15.7–19.0)	14.7 (13.2–16.2)	13.3 (11.8–14.8)	2.1 (1.5–2.8)	—[††]	—[††]	3.9 (3.0–4.7)	2.2 (1.6–2.9)
Illinois	16.3 (15.1–17.4)	14.8 (13.7–15.8)	12.8 (11.8–13.8)	2.5 (2.0–3.1)	0.3 (0.1–0.5)	0.6 (0.3–0.8)	2.0 (1.6–2.4)	1.0 (0.7–1.3)
Indiana	22.5 (20.8–24.3)	20.3 (18.6–22.0)	18.9 (17.3–20.5)	3.1 (2.3–3.9)	—[††]	—[††]	3.1 (2.4–3.9)	2.2 (1.5–2.8)
Iowa	20.8 (18.9–22.6)	17.4 (15.7–19.1)	15.6 (14.0–17.2)	2.6 (1.8–3.3)	—[††]	—[††]	3.1 (2.4–3.9)	3.7 (2.8–4.6)
Kansas	22.1 (20.3–23.9)	19.5 (17.8–21.2)	17.6 (16.0–19.3)	3.0 (2.3–3.8)	0.5 (0.2–0.7)	0.9 (0.5–1.4)	3.5 (2.7–4.3)	2.9 (2.2–3.6)
Kentucky	26.2 (24.3–28.1)	22.4 (20.6–24.2)	21.1 (19.3–22.8)	2.5 (1.7–3.2)	—[††]	—[††]	3.7 (2.8–4.5)	3.8 (2.9–4.7)
Louisiana	21.6 (20.0–23.3)	19.5 (17.9–21.1)	18.6 (17.1–20.2)	2.1 (1.6–2.7)	—[††]	—[††]	2.5 (1.8–3.1)	2.4 (1.8–3.0)
Maine	18.6 (16.8–20.3)	17.8 (16.1–19.6)	16.1 (14.4–17.8)	2.6 (1.9–3.3)	0.8 (0.4–1.2)	—[††]	1.8 (1.2–2.5)	—[††]
Maryland	13.7 (12.3–15.2)	12.5 (11.1–13.9)	10.1 (8.8–11.4)	2.2 (1.6–2.8)	—[††]	—[††]	2.2 (1.5–3.0)	—[††]
Massachusetts	13.3 (11.9–14.7)	12.5 (11.1–13.9)	11.2 (10.0–12.5)	1.8 (1.3–2.4)	—[††]	—[††]	1.6 (1.1–2.1)	—[††]
Michigan	19.9 (18.5–21.3)	18.3 (17.0–19.7)	16.3 (15.0–17.6)	2.5 (1.9–3.1)	0.5 (0.3–0.7)	1.0 (0.5–1.4)	2.9 (2.3–3.4)	1.6 (1.1–2.1)
Minnesota	19.1 (17.6–20.7)	16.4 (14.9–17.8)	14.3 (12.9–15.7)	2.9 (2.2–3.6)	0.5 (0.2–0.8)	0.7 (0.3–1.1)	2.6 (1.9–3.2)	2.4 (1.8–3.0)
Mississippi	23.0 (21.3–24.7)	19.7 (18.1–21.3)	18.5 (17.0–20.1)	2.5 (1.9–3.1)	—[††]	—[††]	2.0 (1.5–2.6)	3.6 (2.8–4.5)
Missouri	20.7 (19.0–22.5)	18.0 (16.3–19.6)	16.9 (15.3–18.5)	2.0 (1.4–2.7)	—[††]	—[††]	3.1 (2.4–3.9)	2.0 (1.4–2.7)
Montana	21.8 (20.0–23.6)	18.5 (16.8–20.2)	16.3 (14.7–17.9)	2.8 (2.0–3.6)	0.9 (0.4–1.4)	—[††]	1.9 (1.3–2.5)	3.8 (3.0–4.6)
Nebraska	19.8 (18.0–21.6)	17.0 (15.3–18.7)	15.3 (13.7–17.0)	2.2 (1.5–2.8)	—[††]	—[††]	3.2 (2.3–4.0)	2.5 (1.8–3.2)
Nevada	16.6 (14.9–18.3)	15.6 (13.9–17.2)	14.1 (12.6–15.7)	1.4 (0.9–1.9)	—[††]	1.4 (0.7–2.1)	2.5 (1.9–3.2)	0.6 (0.2–0.9)
New Hampshire	17.3 (15.7–18.9)	15.9 (14.4–17.5)	14.1 (12.6–15.5)	2.4 (1.7–3.1)	—[††]	—[††]	2.2 (1.5–2.8)	1.0 (0.6–1.5)
New Jersey	12.2 (10.9–13.5)	11.9 (10.6–13.2)	10.1 (8.9–11.3)	2.3 (1.7–2.9)	—[††]	—[††]	1.5 (1.0–2.0)	—[††]
New Mexico	17.1 (15.5–18.8)	15.2 (13.6–16.8)	13.7 (12.2–15.2)	1.9 (1.2–2.5)	—[††]	—[††]	2.5 (1.8–3.1)	1.4 (0.9–1.9)
New York	14.5 (13.5–15.5)	13.8 (12.9–14.8)	12.2 (11.3–13.1)	2.2 (1.8–2.7)	0.3 (0.2–0.5)	0.6 (0.3–0.8)	1.6 (1.2–1.9)	0.6 (0.3–0.8)
North Carolina	20.4 (18.9–21.9)	17.7 (16.3–19.1)	16.0 (14.7–17.4)	2.8 (2.0–3.5)	—[††]	0.7 (0.3–1.0)	2.8 (2.2–3.4)	2.2 (1.6–2.8)
North Dakota	22.6 (20.7–24.5)	19.0 (17.2–20.7)	17.7 (16.0–19.4)	2.1 (1.5–2.7)	—[††]	0.9 (0.4–1.4)	2.2 (1.5–3.0)	4.9 (3.9–6.0)
Ohio	23.8 (22.5–25.2)	20.8 (19.6–22.1)	19.0 (17.8–20.2)	2.6 (2.1–3.2)	0.3 (0.1–0.5)	0.6 (0.3–0.9)	3.2 (2.6–3.8)	2.8 (2.2–3.3)
Oklahoma	23.8 (22.0–25.7)	19.7 (17.9–21.4)	18.5 (16.8–20.2)	2.5 (1.8–3.2)	—[††]	—[††]	3.6 (2.8–4.3)	4.3 (3.4–5.2)
Oregon	17.3 (15.7–19.0)	15.5 (13.9–17.1)	13.9 (12.4–15.4)	2.9 (2.1–3.7)	1.0 (0.6–1.5)	—[††]	3.6 (2.7–4.4)	2.1 (1.4–2.8)
Pennsylvania	20.5 (19.2–21.8)	18.1 (16.9–19.3)	15.8 (14.7–17.0)	3.2 (2.6–3.8)	0.4 (0.2–0.6)	—[††]	2.8 (2.2–3.4)	2.6 (2.1–3.1)
Rhode Island	15.5 (13.6–17.3)	14.3 (12.5–16.1)	11.6 (10.0–13.1)	2.6 (1.8–3.4)	—[††]	—[††]	2.5 (1.7–3.3)	—[††]
South Carolina	20.7 (19.0–22.4)	19.1 (17.5–20.7)	17.7 (16.1–19.2)	2.5 (1.8–3.2)	0.5 (0.2–0.7)	—[††]	2.8 (2.1–3.4)	1.2 (0.8–1.6)
South Dakota	23.0 (21.0–25.1)	19.5 (17.6–21.4)	18.8 (16.9–20.7)	2.3 (1.6–3.1)	—[††]	1.1 (0.6–1.7)	2.0 (1.4–2.7)	4.0 (2.9–5.0)
Tennessee	22.7 (21.1–24.4)	19.7 (18.1–21.3)	18.2 (16.7–19.7)	2.2 (1.6–2.8)	—[††]	—[††]	3.2 (2.5–3.9)	2.8 (2.1–3.5)
Texas	17.0 (16.2–17.9)	15.0 (14.1–15.8)	13.5 (12.7–14.3)	2.1 (1.7–2.4)	0.2 (0.1–0.3)	0.6 (0.3–0.8)	2.4 (2.1–2.8)	1.9 (1.6–2.2)
Utah	10.9 (9.5–12.4)	8.9 (7.6–10.2)	8.0 (6.8–9.2)	1.0 (0.5–1.5)	—[††]	0.9 (0.4–1.3)	3.1 (2.2–3.9)	1.3 (0.7–1.8)
Vermont	18.2 (16.5–19.9)	16.5 (14.9–18.1)	14.8 (13.3–16.3)	1.8 (1.2–2.4)	0.4 (0.2–0.7)	—[††]	1.8 (1.1–2.5)	1.8 (1.2–2.4)
Virginia	17.1 (15.7–18.5)	15.6 (14.2–16.9)	13.2 (12.0–14.5)	2.4 (1.8–3.0)	—[††]	1.1 (0.7–1.6)	2.3 (1.7–2.8)	1.4 (1.0–1.9)
Washington	16.8 (15.3–18.2)	14.8 (13.4–16.1)	12.8 (11.5–14.1)	2.7 (2.0–3.3)	0.8 (0.5–1.2)	0.8 (0.4–1.2)	2.5 (1.9–3.1)	2.2 (1.6–2.7)
West Virginia	26.9 (25.0–28.8)	23.1 (21.2–24.9)	21.7 (19.9–23.5)	1.9 (1.3–2.5)	—[††]	—[††]	3.8 (2.9–4.8)	4.8 (3.9–5.7)
Wisconsin	19.1 (17.5–20.7)	16.8 (15.3–18.3)	15.3 (13.9–16.7)	2.4 (1.7–3.0)	—[††]	—[††]	2.1 (1.5–2.6)	2.2 (1.5–2.9)
Wyoming	27.7 (25.6–29.7)	22.2 (20.3–24.1)	20.2 (18.4–22.0)	2.9 (2.1–3.8)	—[††]	—[††]	4.4 (3.5–5.2)	6.4 (5.2–7.6)

Abbreviation: CI = confidence interval.

* n = 163,920. Data were weighted to adjust for nonresponse and to yield representative estimates at the state level.

† Persons who reported ever use of at least one of the six tobacco products assessed (cigarette, cigar/cigarillo/little cigar, regular pipe, water pipe, e-cigarette, and smokeless tobacco), and reported using the respective product "every day" or "some days" at the time of the survey.

§ Persons who reported having used cigarette, cigar/cigarillo/little cigar, regular pipe, or water pipe at least once during their lifetime and used "every day" or "some days" at the time of the survey.

¶ Persons who reported having smoked ≥100 cigarettes during their lifetime and smoked "every day" or "some days" at the time of survey.

** Persons who reported having used the respective product at least once during their lifetime and used "every day" or "some days" at the time of the survey. Cigars include cigarillos and little cigars. Smokeless tobacco includes moist snuff, dip, spit, chew tobacco, snus, or dissolvable tobacco.

†† Estimates not presented because of relative standard error (RSE) ≥30%.

FIGURE. Proportion of current cigarette smokers* who reported concurrent use of noncigarette product[†] — Tobacco Use Supplement to the Current Population Survey, United States, 2014–2015

21.7%–32.3%
19.3%–21.6%
17.3%–19.2%
11.5%–17.2%
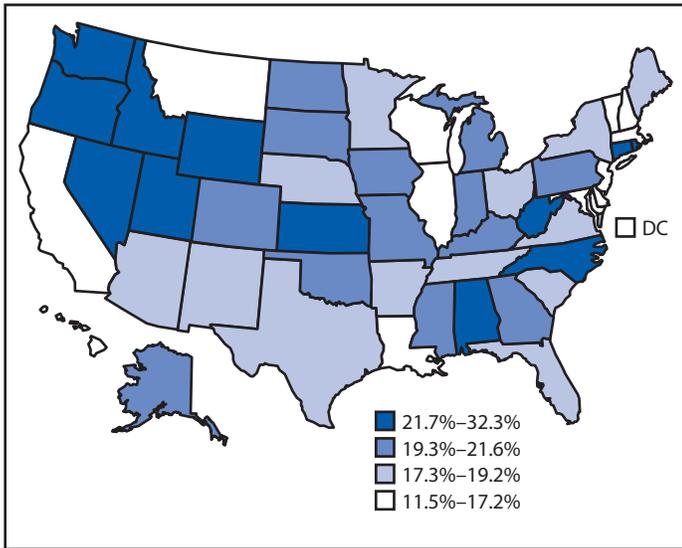
Abbreviation: DC = District of Columbia.

* Current cigarette smokers were persons who reported having smoked ≥100 cigarettes during their lifetime and smoked "every day" or "some days" at the time of the survey (n = 23,232). Data were weighted to adjust for nonresponse and to yield representative estimates at the state level. The proportion of current cigarette smokers that reported concurrent use of a noncigarette tobacco product ranged from 11.5% in Delaware to 32.3% in Oregon.

[†] Noncigarette tobacco products were five tobacco product types assessed in Tobacco Use Supplement to the Current Population Survey (TUS-CPS): cigar/cigarillo/little cigar; regular pipe; water pipe; electronic cigarette; and smokeless tobacco (moist snuff, dip, spit, chew tobacco, snus, or dissolvable tobacco).

Summary

What is already known about this topic?

Tobacco use is the leading cause of preventable morbidity and mortality in the United States. Despite recent declines in cigarette smoking prevalence, the tobacco product landscape has shifted to include emerging tobacco products, such as electronic cigarettes and water pipes.

What is added by this report?

Analysis of data from the 2014–2015 Tobacco Use Supplement to the Current Population Survey found that the prevalence of ever-use of any tobacco product ranged from 27.0% (Utah) to 55.4% (Wyoming). Current (every day or some days) use of any tobacco product ranged from 10.2% (California) to 27.7% (Wyoming). Cigarettes were the most common currently used tobacco product. Among current cigarette smokers, the proportion who currently used ≥1 other tobacco products ranged from 11.5% (Delaware) to 32.3% (Oregon). Eight of the 10 states with the lowest prevalence of current use of any tobacco product have implemented policies that prohibit smoking in all indoor areas of workplaces, bars, and restaurants; seven of the 10 states with the highest prevalence have no such comprehensive smoke-free laws.

What are the implications for public health practice?

Differences in tobacco product use across states underscore the importance of implementing comprehensive tobacco control and prevention interventions to reduce tobacco use and tobacco-related disparities, including comprehensive smoke-free policies, tobacco product price increases, anti-tobacco mass media campaigns, and barrier-free access to clinical smoking cessation resources.

The findings in this report are subject to at least three limitations. First, tobacco use was self-reported and might be underreported. Second, small sample sizes for some tobacco product types within certain states resulted in imprecise estimates that could not be presented. Finally, "ever-use" thresholds were characterized as ≥100 cigarettes versus ≥1 lifetime use for all other products; thus potentially underestimating both ever and current cigarette smoking.

Adoption of evidence-based measures across all states could help decrease tobacco use (3,4). Furthermore, continued tobacco surveillance at the national and state levels can help guide public health programs and policy (4,8).

Conflict of Interest

No conflicts of interest were reported.

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Recommendations of the Advisory Committee on Immunization Practices for Use of Herpes Zoster Vaccines

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Introduction

On October 20, 2017, Zoster Vaccine Recombinant, Adjuvanted (Shingrix, GlaxoSmithKline, [GSK] Research Triangle Park, North Carolina), a 2-dose, subunit vaccine containing recombinant glycoprotein E in combination with a novel adjuvant ($AS01_B$), was approved by the Food and Drug Administration for the prevention of herpes zoster in adults aged ≥50 years. The vaccine consists of 2 doses (0.5 mL each), administered intramuscularly, 2–6 months apart (1). On October 25, 2017, the Advisory Committee on Immunization Practices (ACIP) recommended the recombinant zoster vaccine (RZV) for use in immunocompetent adults aged ≥50 years.

Herpes zoster is a localized, usually painful, cutaneous eruption resulting from reactivation of latent varicella zoster virus (VZV). Herpes zoster is common: approximately one million cases occur each year in the United States (2). The incidence increases with age, from five cases per 1,000 population in adults aged 50–59 years to 11 cases per 1,000 population in persons aged ≥80 years (2). Postherpetic neuralgia, commonly defined as persistent pain for at least 90 days following the resolution of the herpes zoster rash, is the most common complication and occurs in 10%–13% of herpes zoster cases in persons aged >50 years (3,4). Among persons with herpes zoster, the risk for developing postherpetic neuralgia also increases with age (3–5).

Zoster Vaccine Live (ZVL) (Zostavax, Merck and Co., Inc., Whitehouse Station, New Jersey), a 1-dose live attenuated strain of VZV, is licensed for the prevention of herpes zoster in immunocompetent adults aged ≥50 years and is recommended by the ACIP for use in immunocompetent adults aged ≥60 years (6). Since licensure, vaccine coverage has increased each year, and by 2016, 33% of adults aged ≥60 years reported receipt of the vaccine (CDC, provisional unpublished data). ACIP considered use of RZV, as well as existing recommendations, to develop vaccination policy which would be safe and reduce disease burden. This report serves as a supplement to the 2008 Prevention of Herpes Zoster Recommendations of ACIP for the use of ZVL in adults aged ≥60 years and subsequent updates (6–8); it outlines recent ACIP recommendations as well as guidance for use of RZV and ZVL in adults.

Methods

From March 2015 to October 2017, the ACIP Herpes Zoster Vaccines Work Group (Work Group; see acknowledgments for members and their affiliations) participated in monthly or bimonthly teleconferences to review herpes zoster epidemiology and the evidence for the efficacy, safety, and programmatic factors of RZV and ZVL. According to the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach, the Work Group defined critical and important outcomes, conducted a systematic review of the evidence, and subsequently reviewed and discussed findings and evidence quality (https://www.cdc.gov/vaccines/acip/recs/grade/) (9).

A cost effectiveness analysis comparing RZV, ZVL, or no vaccine was conducted by CDC from a societal perspective, using an analytic horizon of time of vaccination through the end of life. Model inputs were based on published literature where available and relied on unpublished data and Work Group expert opinion when necessary. It was modeled that ZVL effectiveness against herpes zoster would wane to zero 4–12 years following vaccination, depending on age at vaccination (4,10–13). In the absence of long-term effectiveness data, it was modeled that RZV effectiveness in adults aged 50–69 years or ≥70 years would wane to zero 19 years following vaccination based on the rate of waning observed during the first 4 years of clinical trials as well as expert opinion (13–15). Economic analyses were also conducted for RZV in cohorts previously vaccinated with ZVL. In keeping with CDC practice (16,17), the purpose of the economic analysis was to model the proposed recommendation; therefore, full adherence to a 2-dose RZV regime was assumed in baseline models. Lower rates of 2-dose adherence were evaluated in sensitivity analyses.

Since 2015, RZV was discussed at five ACIP meetings. In addition to the aforementioned data, several independent health economic studies (18,19), (Merck, unpublished data, 2017), as well as immunogenicity data were presented. Long-term immunogenicity of RZV (20) and immunogenicity and safety of RZV in ZVL recipients (21) were considered, with recognition that there are no standard immunologic correlates of protection for prevention of herpes zoster.

At the October 2017 meeting, three proposed recommendations were presented to the committee, and, after a public

comment period, were approved by the voting ACIP members as follows: 1) RZV is recommended for immunocompetent adults aged ≥50 years (14 voted in favor, 1 opposed*), 2) RZV is recommended for immunocompetent adults previously vaccinated with ZVL (12 voted in favor, 3 opposed), and 3) RZV is preferred over ZVL (8 voted in favor, 7 opposed). This report summarizes the data considered, the quality of evidence, and rationale for recommendations.

Summary of Findings

As a result of the GRADE process, key outcomes were designated as critical (prevention of herpes zoster and postherpetic neuralgia, serious adverse events following vaccination) or important (duration of protection, reactogenicity). All outcomes were considered for both RZV and ZVL compared with no vaccination. There were no clinical studies that compared the vaccines directly with one another (head-to-head). Supporting evidence for the Work Group's findings is available online (https://www.cdc.gov/vaccines/acip/recs/grade/herpes-zoster.html) (22).

Recombinant Zoster Vaccine (RZV). Efficacy of RZV was evaluated in a two-part, phase III multicenter clinical trial which enrolled >30,000 participants, who were randomized 1:1 to receive vaccine or saline placebo (14,15). The median follow-up time was 3.2 years for Zoster Efficacy Study in Adults 50 Years of Age or Older (ZOE-50) (14), and 3.7 years for Zoster Efficacy Study in Adults 70 Years of Age or Older (ZOE-70) (15). The efficacy for the prevention of herpes zoster was 96.6% (95% confidence interval [CI] = 89.6–99.3) in persons aged 50–59 years and 97.4% (95% CI = 90.1–99.7) in persons aged 60–69 years (14). Using pooled data from both study arms, vaccine efficacy was 91.3% (95% CI = 86.8–94.5) in participants aged ≥70 years (15). Vaccine efficacy in the first year after vaccination was 97.6% (95% CI = 90.9–99.8) and was 84.7% (95% CI = 69.0–93.4) or higher for the remaining 3 years of the study in persons aged ≥70 years. Efficacy for prevention of postherpetic neuralgia was 91.2% (95% CI = 75.9–97.7) in adults aged ≥50 years and 88.8% (95% CI = 68.7–97.1) in those aged ≥70 years (15).

Serious adverse events (an undesirable experience associated with the vaccine that results in death, hospitalization, disability or requires medical or surgical intervention to prevent a serious outcome) were examined in eight studies sponsored by GSK, which included 29,965 subjects (15,264 RZV recipients) (22). Overall, rates of serious adverse events over the study periods were similar in the RZV and placebo groups.

Injection-site and systemic grade 3 solicited adverse events (reactions related to vaccination which were severe enough to prevent normal activities) were actively surveyed in eight studies involving 10,590 subjects (22). Among the subset of subjects completing the 7-day diary card for reactogenicity in phase III clinical trials (9,936), 16.5% of vaccine recipients reported any grade 3 adverse event compared with 3.1% of placebo recipients (14,15). Grade 3 injection-site reactions (pain, redness, and swelling) were reported by 9.4% of vaccine recipients, compared with 0.3% of placebo recipients and grade 3 solicited systemic events (myalgia, fatigue, headache, shivering, fever, and gastrointestinal symptoms) were reported by 10.8% of vaccine recipients and 2.4% of placebo recipients (14,15). Whereas there were no differences in the proportions of local grade 3 reactions between dose 1 and dose 2, systemic grade 3 reactions were reported more frequently after dose 2 (1). Overall, the most common solicited adverse reactions (grade 1–3) were pain (78%), myalgia (45%), and fatigue (45%) (1).

Zoster Vaccine Live (ZVL). Two randomized clinical trials and seven observational studies were reviewed to evaluate the performance of a single dose of ZVL in preventing herpes zoster (22). A randomized clinical trial in persons aged 50–59 years found that the efficacy was 70% (95% CI = 54–81) (median follow-up time was 1.3 years) (12). A randomized trial in persons aged ≥60 years found that the efficacy was 64% (95% CI = 56–71) in persons aged 60–69 years and 38% (95% CI = 25–48) in persons aged ≥70 (median follow-up time was 3.1 years) (4). Estimates from observational studies and randomized controlled trials (RCTs) are consistent; observational estimates are within the 95% CI of the RCT estimates (22). The duration of protection has been studied out to 11 years, including the first 4 years of the RCT and then follow-on, nonblinded studies which used a modeled control group from years 7–11 (4,10,11). Shorter follow-up periods have been evaluated in observational studies using administrative health data (22). Studies concur that there is a substantial decrease in effectiveness following the first year after receipt of ZVL, and, by 6 years postvaccination, vaccine effectiveness against herpes zoster is <35% (10,23–25). During years 7–8 postvaccination, observational study estimates of effectiveness ranged from 21%–32% (23,24). In the longest study of ZVL, estimates of effectiveness were no longer statistically significant 9–11 years postvaccination (11). In a phase III clinical trial, vaccine efficacy against post herpetic neuralgia was 65.7% (95% CI = 20.4–86.7) in persons aged 60–69 years and 66.8% (95% CI = 43.3–81.3) in participants aged ≥70 years (median follow-up of 3.1 years) (4); these estimates are consistent with estimates from observational studies (22). Notably, in observational studies, vaccine effectiveness against postherpetic

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* Laura Riley submitted that her opposed vote was cast in error. This is reflected in the official minutes; however, because the disclosure occurred after the session was closed, the original vote remains unchanged.

neuralgia was longer-lasting than effectiveness against herpes zoster itself (*23,26*).

Serious adverse events related to ZVL were examined in eight high quality RCTs, 13 RCTs with limitations, and an additional seven observational studies (*22*). Overall, serious adverse events occurred at similar rates in vaccinated and placebo groups. Whereas injection site reactions were reported in 48% of vaccine recipients and 17% of placebo recipients in phase III clinical trials, post hoc analysis indicates that no more than 0.9% of vaccine recipients reported any given injection site symptom as grade 3 (*22*). In addition, in rare instances, ZVL vaccine strain has been documented to cause disseminated rash as well as herpes zoster in immunocompetent recipients (*22,27*), and life-threatening and fatal complications in immunocompromised recipients (*28,29*).

Cost effectiveness. The CDC analysis was conducted from a societal perspective over a lifetime. It estimated that vaccination with RZV, compared with no vaccination, cost $31,000 per quality adjusted life year (QALY), on average, for immunocompetent adults aged ≥50 years. The numbers of persons needed to be vaccinated with RZV to prevent one case of herpes zoster and one case of postherpetic neuralgia are 11–17 and 70–187, respectively. Estimates of costs per QALY for vaccination with RZV 8 weeks following ZVL (estimated by immediate revaccination in the model) ranged from $15,000 per QALY in persons aged 80–89 years to $117,000 per QALY for persons aged 50–59 years. Under most assumptions, vaccination with RZV prevented more disease at lower overall costs than did vaccination with ZVL. In probabilistic sensitivity analyses, 73.5% 2-dose completion (range = 38.8%–96.3%) coupled with 1-dose initial effectiveness estimates of 90% and 69% were applied, and RZV remained the most cost-effective strategy (*13*).

ACIP also reviewed independent cost-effectiveness analyses by an academic group (*18*), GSK (*19*), and Merck (Merck, unpublished data, 2017). The academic group estimated RZV costs per QALY of $30,000 when vaccination occurred at age 60 years. The GSK model estimated RZV costs per QALY of $12,000, on average, for recipients aged ≥60 years. Although analytic approaches and model inputs differed, both groups found that RZV was more cost effective than ZVL. Merck modeled vaccination at age ≥60 years and estimated $107,000 per QALY for RZV and $83,000 per QALY for ZVL, with ZVL as the most cost-effective vaccine in most scenarios.

Summary of the Quality of Evidence Across Outcomes

The body of evidence for benefits of RZV (prevention of herpes zoster and postherpetic neuralgia and duration of protection against herpes zoster) was primarily informed by one high quality RCT that studied vaccine efficacy through 4 years postvaccination. The GRADE evidence type was judged as 1, the strongest level of evidence (*22*). The evidence for possible harms (serious adverse events and reactogenicity) was reported in the same RCT and was consistent across additional smaller, less rigorous studies. Overall, the estimates of possible harms were supported by GRADE evidence type 1 (*22*).

The body of evidence for benefits of ZVL (prevention of herpes zoster and postherpetic neuralgia, and duration of protection against herpes zoster) was large, including a high quality prelicensure RCT as well as a postlicensure RCT and observational studies of effectiveness. The level of vaccine effectiveness for the prevention of herpes zoster and postherpetic neuralgia was supported by GRADE evidence type 1 (*22*). The duration of protection beyond 4 years was supported by GRADE evidence type 2 because the studies lacked blinding, and beyond 6 years, lacked randomization and a true control group. The evidence for possible harms of ZVL (serious adverse events and reactogenicity) was supported by GRADE evidence type 1 from multiple RCTs and supported by observational studies and a decade of experience (*22,29*).

Rationale

RZV use in immunocompetent adults aged ≥50 years. With high efficacy among adults aged ≥50 years, and modest waning of protection over 4 years following vaccination, RZV has the potential to prevent substantial herpes zoster disease burden. Vaccinating adults starting at age 50 will prevent disease incidence in midlife, and the vaccine will likely continue to provide substantial protection beyond 4 years as recipients age.

RZV use in immunocompetent adults who previously received ZVL. In separate clinical trials, RZV estimates of efficacy against herpes zoster were higher than ZVL estimates in all age categories. The difference in efficacy between the two vaccines was most pronounced among recipients aged ≥70 years. Studies have shown that ZVL effectiveness wanes substantially over time, leaving recipients with reduced protection against herpes zoster. RZV elicited similar safety, reactogenicity, and immunogenicity profiles regardless of prior ZVL receipt; therefore, ZVL recipients will likely benefit from vaccination with RZV.

Preferential use of RZV. In separate clinical trials, for all age categories, RZV estimates of efficacy against herpes zoster were higher than those for ZVL. Estimates of efficacy against postherpetic neuralgia are also higher for RZV than for ZVL; however, CIs overlap. ZVL efficacy wanes substantially during the 4 years following receipt. As a result of higher and more long-lasting efficacy, RZV is estimated to prevent more herpes zoster and postherpetic neuralgia compared with ZVL. ACIP acknowledged that several aspects of RZV performance will

be further elucidated postlicensure, including the possibility of a rare adverse event related to the vaccine, the long-term duration of protection, the adherence to the 2-dose schedule, and the effectiveness and duration of protection of 1 dose of RZV. Some ACIP members preferred to recommend both vaccines with no preference until real-world data could be accrued, including head-to-head studies. The majority of ACIP members voted to recommend RZV preferentially (Box).

Clinical Guidance

General use. RZV may be used in adults aged ≥50 years, irrespective of prior receipt of varicella vaccine or ZVL, and does not require screening for a history of chickenpox (varicella). ZVL remains a recommended vaccine for prevention of herpes zoster in immunocompetent adults aged ≥60 years (6). Care should be taken not to confuse ZVL, which is stored in the freezer and administered subcutaneously, with RZV, which is stored in the refrigerator and administered intramuscularly.

Dosing schedule. Following the first dose of RZV, the second dose should be given 2–6 months later (1). The vaccine series need not be restarted if more than 6 months have elapsed since the first dose; however, the efficacy of alternative dosing regimens has not been evaluated, data regarding the safety of alternative regimens are limited (30), and individuals might remain at risk for herpes zoster during a longer than recommended interval between doses 1 and 2. If the second dose of RZV is given less than 4 weeks after the first, the second dose should be repeated. Two doses of the vaccine are necessary regardless of prior history of herpes zoster or prior receipt of ZVL.

Timing of RZV for persons previously vaccinated with ZVL. Age and time since receipt of ZVL may be considered to determine when to vaccinate with RZV. Studies examined the safety and immunogenicity of RZV vaccination administered ≥5 years after ZVL (21); shorter intervals have not been studied. However, there are no data or theoretical concerns to indicate that RZV would be less safe or less effective when administered at an interval of <5 years. Clinical trials indicated lower efficacy of ZVL in adults aged ≥70 years; therefore, a shorter interval may be considered based on the recipient's age when ZVL was administered. Based on expert opinion, RZV should not be given <2 months after receipt of ZVL.

Coadministration with other vaccines. CDC's general best practice guidelines for immunization advise that recombinant and adjuvanted vaccines, such as RZV, can be administered concomitantly, at different anatomic sites, with other adult vaccines (31). Concomitant administration of RZV with Fluarix Quadrivalent (influenza vaccine) (QIV) has been studied, and there was no evidence for interference in the immune response

BOX. Recommendations for the use of herpes zoster vaccines

> In October 2017, the Advisory Committee on Immunization Practices (ACIP) made the following three recommendations:
> 1. Recombinant zoster vaccine (RZV) is recommended for the prevention of herpes zoster and related complications for immunocompetent adults aged ≥50 years.
> 2. RZV is recommended for the prevention of herpes zoster and related complications for immunocompetent adults who previously received zoster vaccine live (ZVL).
> 3. RZV is preferred over ZVL for the prevention of herpes zoster and related complications.
>
> These recommendations serve as a supplement to the existing recommendations for the use of ZVL in immunocompetent adults aged ≥60 years.

to either vaccine or safety concerns (32). Evaluation of coadministration of RZV with 23-valent pneumococcal polysaccharide vaccine (PPSV23, Pneumovax23) and tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine, adsorbed (Tdap, Boostrix) is ongoing. The safety and efficacy of administration of two adjuvanted vaccines (e.g., RZV and adjuvanted influenza vaccine [Fluad]), either concomitantly or at other intervals, have not been evaluated.

Counseling for reactogenicity. Before vaccination, providers should counsel RZV recipients about expected systemic and local reactogenicity. Reactions to the first dose did not strongly predict reactions to the second dose (33); vaccine recipients should be encouraged to complete the series even if they experienced a grade 1–3 reaction to the first dose of RZV. The impact of prophylactic analgesics in conjunction with RZV has not been studied.

Special Populations

Persons with a history of herpes zoster. Herpes zoster can recur. Adults with a history of herpes zoster should receive RZV. If a patient is experiencing an episode of herpes zoster, vaccination should be delayed until the acute stage of the illness is over and symptoms abate. Studies of safety and immunogenicity of RZV in this population are ongoing.

Persons with chronic medical conditions. Adults with chronic medical conditions (e.g., chronic renal failure, diabetes mellitus, rheumatoid arthritis, and chronic pulmonary disease) should receive RZV.

Immunocompromised persons. As with ZVL, the ACIP recommends the use of RZV in persons taking low-dose immunosuppressive therapy (e.g., <20 mg/day of prednisone or equivalent or using inhaled or topical steroids) and persons anticipating immunosuppression or who have recovered from an immunocompromising illness (6). Whereas RZV is licensed for all persons aged ≥50 years, immunocompromised persons and those on moderate to high doses of immunosuppressive therapy were excluded from the efficacy studies (ZOE-50 and ZOE-70), and thus, ACIP has not made recommendations regarding the use of RZV in these patients; this topic is anticipated to be discussed at upcoming ACIP meetings as additional data become available.

Persons known to be VZV negative. Screening for a history of varicella (either verbally or via laboratory serology) before vaccination for herpes zoster is not recommended. However, in persons known to be VZV negative via serologic testing, ACIP guidelines for varicella vaccination should be followed. RZV has not been evaluated in persons who are VZV seronegative and the vaccine is not indicated for the prevention of chickenpox (varicella).

Contraindication

Allergy. RZV should not be administered to persons with a history of severe allergic reaction, such as anaphylaxis, to any component of this vaccine.

Precautions

Current herpes zoster infection. RZV is not a treatment for herpes zoster or postherpetic neuralgia and should not be administered during an acute episode of herpes zoster.

Pregnancy and breastfeeding. There are no available data to establish whether RZV is safe in pregnant or lactating women and there is currently no ACIP recommendation for RZV use in this population. Consider delaying vaccination with RZV in such circumstances.

Reporting of Vaccine Adverse Reactions

Adverse events that occur in a patient following vaccination can be reported to the Vaccine Adverse Events Reporting System (VAERS). Reporting is encouraged for any clinically significant adverse event even if it is uncertain whether the vaccine caused the event. Information on how to submit a report to VAERS is available at https://vaers.hhs.gov/index.html or by telephone at 1–800–822–7967.

Future Research and Monitoring Priorities

Studies of safety, immunogenicity, and efficacy of herpes zoster vaccines in defined immunocompromised populations are ongoing. ACIP will consider these data as they become available and revise recommendations accordingly. In addition, CDC will monitor coverage of RZV and adherence to the 2-dose schedule. Short-term and long-term effectiveness of RZV will be assessed through longitudinal studies of clinical trial participants as well as through observational studies.

As with all new vaccines, CDC will monitor adverse events following immunization through VAERS and the Vaccine Safety Datalink. Additional post-marketing safety monitoring will include studies conducted by GSK and reported to the FDA. Monitoring RZV is particularly important given the vaccine's novel adjuvant and its high reactogenicity and immunogenicity.

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Notes from the Field

Errors in Administration of an Excess Dosage of Yellow Fever Vaccine — United States, 2017

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Yellow fever vaccine (YF-VAX, Sanofi Pasteur, Swiftwater, Pennsylvania) is a live, attenuated virus vaccine recommended for persons aged ≥9 months who are traveling to or living in areas with risk for yellow fever virus transmission (*1*). For persons of all ages for whom vaccination is indicated, a single subcutaneous injection of 0.5 mL of reconstituted vaccine is used. Because no specific treatment for yellow fever exists, prevention through vaccination is critical to reduce yellow fever–associated morbidity and mortality (*2*). YF-VAX is the only yellow fever vaccine licensed in the United States, and approximately 500,000 doses are distributed annually to vaccinate military and civilian travelers. Yellow fever vaccine is supplied only to designated Yellow Fever Vaccination Centers authorized to issue certificates of yellow fever vaccination. YF-VAX is available in single-dose and 5-dose vials. Single-dose vials of lyophilized (freeze-dried) vaccine are supplied in a package of five vials of vaccine (Figure); five vials of diluent are provided separately (each vial of diluent contains 0.6 mL sodium chloride for injection USP). Five-dose vials are supplied in a package containing one vial (Figure), and diluent is supplied separately in one vial containing 3 mL sodium chloride for injection USP. The manufacturer's instructions specify that the vaccine is to be used within 60 minutes of reconstituting either the single-dose or the 5-dose vial.

In March 2017, four persons at a single military clinic were vaccinated in error, each receiving an entire 5-dose vial of YF-VAX reconstituted with 0.6 mL of diluent before administration. No specific adverse events were reported; all persons were evaluated in an emergency department (ED) and released. The error was reported to the Vaccine Adverse Event Reporting System (VAERS) (*3*), which prompted CDC to search the VAERS database for similar reports of incorrect dosage administration of YF-VAX. Eleven reports of similar errors in vaccine administration were identified, including a cluster of seven persons vaccinated at another military clinic in 2007 and four other reports (one from a public health clinic in 2010, two from separate military clinics in 2011 and 2013, and one from an unknown type of clinic in 2013). Among the 15 patients identified, five were evaluated in an ED, and one had a doctor's evaluation in a clinic. Only one report described symptoms; a man aged 30 years was evaluated in an ED for

FIGURE. Yellow fever vaccine (YF-VAX, Sanofi Pasteur, Swiftwater, Pennsylvania) supplied as five single-dose vials (top) and one 5-dose vial (bottom)*
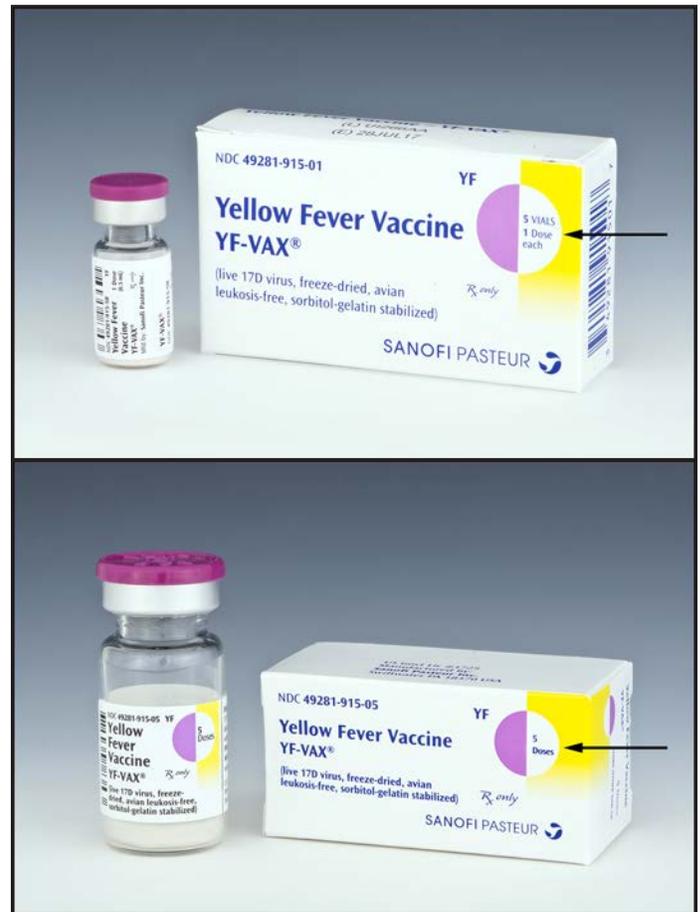
Photo/Sanofi Pasteur
* Arrows indicate package identification of number of doses supplied.

intermittent upper abdominal pain and arm pain 1 day after inadvertent receipt of a 5-dose vial; his symptoms resolved following supportive intravenous treatment.

Reports of similar administration errors are rare. Three Brazilian reports involved multidose vials of 17-DD yellow fever vaccine (Bio-Manguinhos, Rio de Janeiro, Brazil) used in mass vaccination campaigns (*4–6*); 14 health care workers were asymptomatic following receipt of a 25-fold overdose (*4*); one person received a 12.5-fold overdose but was lost to follow up (*5*); and a 45-day clinical follow up of 49 persons who received a 10-fold overdose identified one child who was hospitalized for evaluation of possible acute viscerotropism and recovered (*6*).

Most reports did not involve an adverse event, but the error was costly in terms of follow-up medical evaluation and vaccine waste. Vaccine providers should follow the instructions provided with YF-VAX; preventive measures such as more distinctive packaging and in-service training in clinics that stock both the single and multidose vials might be helpful.

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QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage* of Emergency Department Visits for Acute Viral Upper Respiratory Tract Infection[†] That Had an Antimicrobial Ordered or Prescribed,[§] by Metropolitan Statistical Area[¶] — United States, 2008–2015**
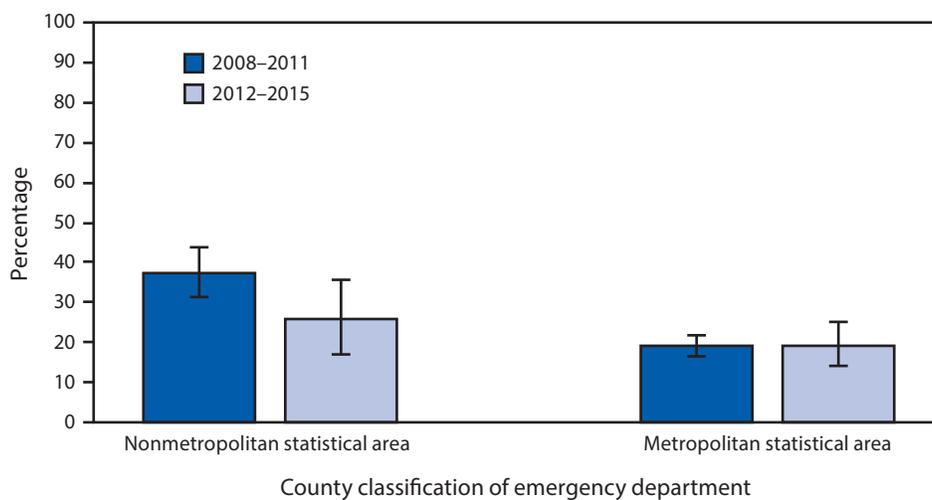
* With 95% confidence intervals indicated with error bars.
[†] Acute viral upper respiratory tract infection defined as a visit with only one listed diagnosis and this diagnosis had an *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) code for acute nasopharyngitis (ICD-9-CM 460), acute laryngitis and tracheitis (ICD-9-CM 464.xx), acute respiratory infections of multiple or unspecified sites (ICD-9-CM 465.xx), or cough (ICD-9-CM 786.2).
[§] Antimicrobial medications included drugs categorized as anti-infectives, derived from Level 1 therapeutic categories from Multum Lexicon Plus.
[¶] Metropolitan statistical area definitions are compiled per Office of Management and Budget definitions of core-based statistical areas and are based on the county of the emergency department. Metropolitan statistical area is defined as a core urban area of ≥50,000 population. Nonmetropolitan statistical area is defined as an area of <50,000 population.
** Based on a sample of visits to emergency departments in noninstitutional general and short-stay hospitals, exclusive of Federal, military, and Veterans Administration hospitals, located in 50 states and the District of Columbia.

From 2008–2011 to 2012–2015, the percentage of visits for acute viral upper respiratory tract infection that had an antimicrobial ordered or prescribed decreased from 37.1% to 25.5% among emergency departments (EDs) located in nonmetropolitan statistical areas, but this decline was not seen among EDs in metropolitan statistical areas. In 2008–2011, the percentage was higher among nonmetropolitan EDs than metropolitan EDs, but there was no difference in 2012–2015.

Source: National Center for Health Statistics, National Hospital Ambulatory Medical Care Survey, 2008–2015. https://www.cdc.gov/nchs/ahcd/ahcd_questionnaires.htm.

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