Centers for Disease Control and Prevention

MMWR

Morbidity and Mortality Weekly Report

Weekly / Vol. 66 / No. 8 March 3, 2017

Cancer Screening Test Use — United States, 2015

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Healthy People 2020 (HP2020) includes objectives to increase screening for breast, cervical, and colorectal cancer (*1*) as recommended by the U.S. Preventive Services Task Force (USPSTF).* Progress toward meeting these objectives is monitored by measuring cancer screening test use against national targets using data from the National Health Interview Survey (NHIS) (*1*). Analysis of 2015 NHIS data indicated that screening test use remains substantially below HP2020 targets for selected cancer screening tests. Although colorectal cancer screening test use increased from 2000 to 2015, no improvements in test use were observed for breast and cervical cancer screening. Disparities exist in screening test use by race/ethnicity, socioeconomic status, and health care access indicators. Increased measures to implement evidence-based interventions and conduct targeted outreach are needed if the HP2020 targets for cancer screening are to be achieved and the disparities in screening test use are to be reduced.

NHIS is a cross-sectional household interview survey that yields data on a nationally representative sample of the civilian, noninstitutionalized population residing in the United States (*2*). Information is collected about the household, each person in the family residing in that household, and a randomly selected sample adult (aged ≥18 years) and child (if present) from each family. This analysis includes data from the cancer control supplement, sample adult questionnaire, person files, and imputed income files. For each cancer screening test, adults were asked whether they had ever received the test. Those who answered that they had received a cancer screening test were then asked when the most recent screening test occurred (*2*). For this analysis, any report of testing for cancer was considered a screening test for the purpose of estimating proportions of the population up to date with breast, cervical, and colorectal cancer screening consistent with USPSTF recommendations as of 2015 (i.e., mammography within 2 years for women aged 50–74 years; Papanicolaou [Pap] test within 3 years for women without a hysterectomy aged 21–65 or Pap test with human papillomavirus test [HPV] within 5 years for women without a hysterectomy aged 30–65 years; fecal occult blood test within 1 year, sigmoidoscopy within 5 years and fecal occult blood test within 3 years, or colonoscopy within 10 years for respondents aged 50–75 years). Crude percentages, along with corresponding 95% confidence intervals, were presented by sociodemographic and health care–access characteristics, such as source of usual care. Overall percentages were age-adjusted, with age standardized to the 2000 U.S. standard population. Because the covariate associations for colorectal cancer screening use were similar by sex, results are reported for men and

* https://www.uspreventiveservicestaskforce.org/Page/Name/recommendations.

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women combined. Statistical testing for differences in screening test use by sociodemographic and health care–access characteristics was performed using Wald F tests. For each screening exam, screening trends over time were examined using NHIS data from 2000, 2003, 2005, 2008, 2010, 2013, and 2015. To account for changes in cervical cancer screening recommendations over time, only trends for Pap test within 3 years for women aged 21–65 years without hysterectomy were assessed. The Wald F test was used to determine whether differences in screening across the years occurred. All statistics presented are based on data weighted to account for the complex survey design of NHIS.

The final sample adult response rate was 55.2% (*2*). Mammography use remained stable from 2000 to 2015 (Figure). In 2015, 71.5% of women aged 50–74 years reported having had a mammogram within the past 2 years, which is less than the HP2020 target of 81.1% (Figure) (Table 1). Compared with other racial/ethnic groups, mammography use was lowest among American Indians/Alaska Natives (AI/AN) (56.7%). Filipino women were the only group that met the HP2020 target. Use was lower among women who were foreign-born and in the United States for <10 years (53.7%) than among those who were U.S.-born (72.1%). The proportion of women who had a mammogram increased with increasing education and income levels. Mammography use was lowest for women who reported being uninsured (35.3%) and without a usual source of health care (32.9%) (Table 1).

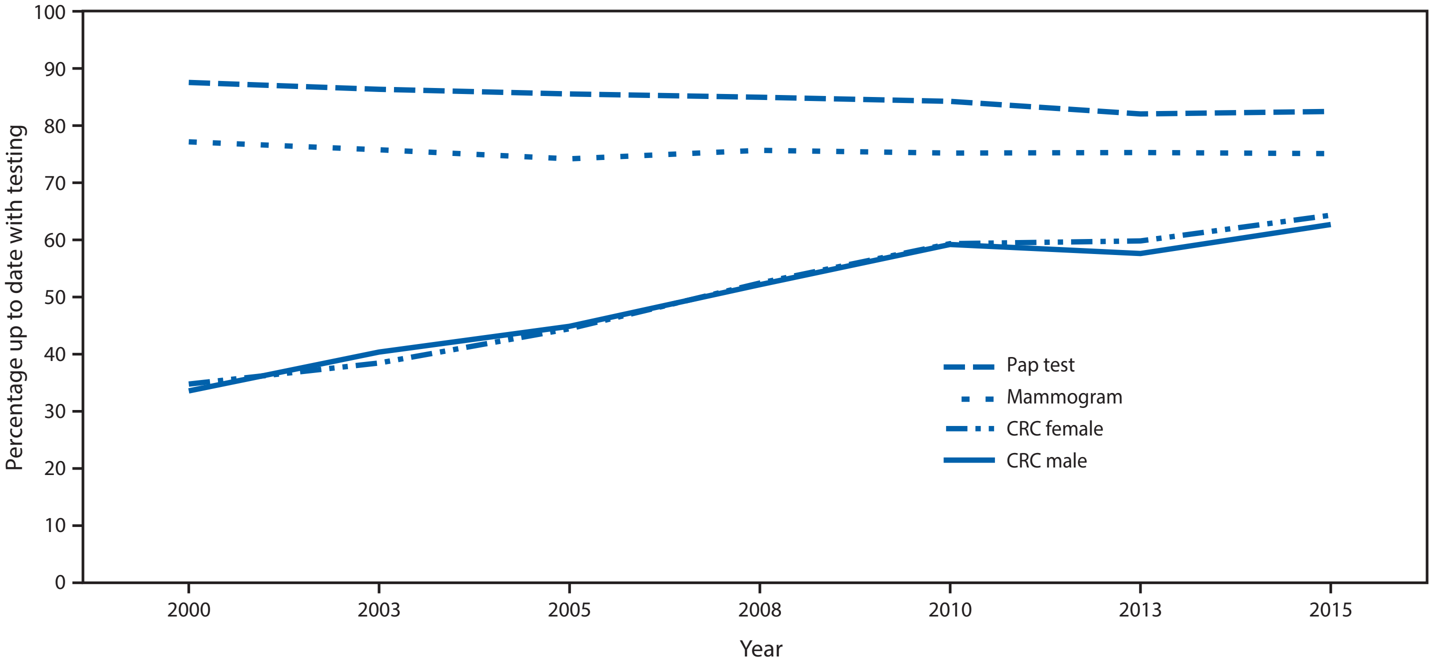
From 2000 to 2015, the overall trend for cervical cancer screening (Pap test) use declined (Figure). In 2015, 83% of women reported being up to date with cervical cancer screening, which is below the HP2020 target of 93.0% (Figure) (Table 1). Cervical cancer screening use was lowest among Asian women (75.8%), especially Chinese (72.0%) and other Asian women (71.6%). Hispanics (78.6%) reported lower screening than did non-Hispanics (83.7%). Compared with all other age groups, women aged 21–30 years reported the lowest cervical cancer screening test use (78.3%). Women who were foreign-born, regardless of their duration of U.S. residence, had lower screening test use than U.S.-born women. The proportion of women reporting cervical cancer screening use increased with education and income levels. Cervical cancer screening use was lower among women without a usual source of health care (65.1%) than among women who had a usual source of care (85.5%). Compared with women who had insurance coverage, cervical cancer screening test use was lowest (63.8%) among uninsured women (Table 1).

From 2000 to 2015, colorectal cancer test use increased, but did not reach the HP2020 target of 70.5% (Figure). During 2015, 62.4% of men and women reported colorectal cancer screening test use consistent with USPSTF recommendations. By racial group, colorectal cancer screening use was lowest among AI/ANs (48.4%) (Table 2). By ethnicity, Hispanics reported lower screening test use (47.4%) than did non-Hispanics (64.2%). Reported screening was lower among persons aged 50–64 years (57.9%) than among persons

The *MMWR* series of publications is published by the Center for Surveillance, Epidemiology, and Laboratory Services, Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, Atlanta, GA 30329-4027.

Suggested citation: [Author names; first three, then et al., if more than six.] [Report title]. MMWR Morb Mortal Wkly Rep 2017;66:[inclusive page numbers].

FIGURE. Percentage of adults who were up to date with screening for breast,* cervical,† and colorectal§ cancers, by test, sex, and year — United States, 2000–2015



Abbreviation: CRC = colorectal cancer.

* The U.S. Preventive Services Task Force (USPSTF) recommends mammography within 2 years for women aged 50–74 years.

† USPSTF recommends Papanicolaou (Pap) test within 3 years for women aged 21–65 years without hysterectomy, or Pap test with human papillomavirus test within 5 years for women aged 30–65 years without hysterectomy. To account for changing screening recommendations over time for cervical cancer for women aged 21–65 years without hysterectomy, only trends for Pap test within 3 years for women aged 21–65 years without hysterectomy were assessed; Pap test data for 2003 are missing.

§ The USPSTF recommends three options for CRC screening: 1) fecal occult blood test within 1 year; 2) sigmoidoscopy within 5 years and fecal occult blood test within 3 years; or 3) colonoscopy within 10 years for respondents aged 50–75 years.

TABLE 1. Percentage of women who received recent breast and cervical cancer screenings, by selected sociodemographic characteristics and health care access — National Health Interview Survey, United States, 2015

	Breast cancer			Cervical cancer		
	Mammogram within ≤2 yrs*			Pap test within ≤3 yrs or Pap + HPV within ≤5 yrs†		
Characteristic	**No. (%§)**	**95% CI**	**p-value**	**No. (%§)**	**95% CI**	**p-value**
Overall						
Crude	6,747 (71.6)	70.1–73.0	NA	10,477 (82.8)	81.8–83.8	NA
Age-adjusted¶	6,747 (71.5)	70.1–73.0		10,477 (83.0)	82.0–84.0	
Race**						
White	5,298 (71.8)	70.1–73.4	p = 0.035	7,844 (83.2)	82.0–84.3	p<0.001
Black	1,015 (74.3)	70.3–78.0		1,664 (85.3)	82.9–87.3	
American Indian/Alaska Native	86 (56.7)	43.0–69.4		171 (76.9)	66.9–84.6	
Asian	311 (66.1)	59.1–72.4		690 (75.8)	71.4–79.7	
Chinese	55 (72.3)	55.4–84.6		151 (72.0)	63.8–79.0	
Filipino	88 (81.5)	67.5–90.4		169 (88.9)	81.4–93.7	
Other Asian	168 (57.4)	48.0–66.3		370 (71.6)	65.5–77.0	
Ethnicity††						
Non-Hispanic	5,906 (71.5)	69.9–73.1	p = 0.791	8,375 (83.7)	82.6–84.8	p<0.001
Hispanic	841 (72.1)	67.8–76.0		2,102 (78.6)	76.2–80.8	
Puerto Rican	118 (78.1)	66.5–86.5		222 (79.5)	70.1–86.6	
Mexican	272 (66.2)	59.3–72.5		864 (77.0)	73.0–80.6	
Mexican-American	163 (77.2)	67.4–84.8		417 (79.0)	72.8–84.1	
Central/South American	144 (74.6)	64.6–82.6		359 (80.6)	74.5–85.5	
Other Hispanic	118 (78.1)	66.5–86.5		240 (80.5)	72.1–86.8	

See table footnotes on next page.

TABLE 1. (*Continued*) Percentage of women who received recent breast and cervical cancer screenings, by selected sociodemographic characteristics and health care access — National Health Interview Survey, United States, 2015

	Breast cancer			Cervical cancer		
	Mammogram within ≤2 yrs*			Pap test within ≤3 yrs or Pap + HPV within ≤5 yrs†		
Characteristic	No. (%§)	95% CI	p-value	No. (%§)	95% CI	p-value
Age group (yrs)						
21–30	—§§	—§§	p = 0.556	2,594 (78.3)	75.9–80.5	p<0.001
31–40	—§§	—§§		2,647 (87.2)	85.4–88.9	
41–50	—§§	—§§		2,180 (84.6)	82.5–86.5	
51–65	—§§	—§§		3,056 (82.0)	80.2–83.7	
50–64	4,312 (71.3)	69.4–73.1		—§§	—§§	
65–74	2,435 (72.2)	69.7–74.5		—§§	—§§	
Sexual orientation						
Gay	94 (77.2)	65.0–86.1	p = 0.380	177 (74.6)	64.9–82.4	p = 0.006
Straight	6,509 (71.8)	70.3–73.2		10,000 (83.3)	82.2–84.2	
Bisexual	26 (38.3)¶¶	14.5–69.5¶¶		161 (77.9)	68.5–85.1	
Period of U.S. residence						
U.S.-born	5,692 (72.1)	70.5–73.6	p = 0.034	8,232 (84.5)	83.3–85.5	p<0.001
In U.S. <10 yrs	74 (53.7)	40.2–66.8		467 (67.3)	62.2–72.0	
In U.S. ≥10 yrs	971 (70.0)	65.9–73.8		1,760 (79.3)	76.7–81.6	
Education						
Less than high school	867 (60.3)	55.7–64.7	p<0.001	1,215 (71.2)	67.6–74.5	p<0.001
High school graduate/GED	1,698 (68.3)	65.3–71.2		2,130 (76.4)	73.8–78.9	
Some college/Associate degree	2,187 (71.0)	68.2–73.8		3,436 (83.1)	81.1–84.9	
College graduate	1,970 (78.9)	76.4–81.2		3,670 (89.5)	88.1–90.7	
Percentage of federal poverty threshold						
<139	1,571 (58.7)	55.0–62.3	p<0.001	2,960 (75.2)	72.9–77.4	p<0.001
139–250	1,323 (63.4)	59.3–67.4		2,075 (78.2)	75.5–80.7	
251–400	1,311 (73.8)	70.5–76.9		1,960 (82.3)	79.9–84.4	
>400	2,542 (78.8)	76.6–80.9		3,481 (89.7)	88.2–90.9	
Usual source of health care						
None or hospital emergency department	393 (32.9)	26.9–39.6	p<0.001	1,406 (65.1)	61.5–68.6	p<0.001
Has usual source	6,352 (73.8)	72.3–75.3		9,069 (85.5)	84.5–86.5	
Health care coverage						
Private	4,186 (76.7)	74.9–78.5	p<0.001	6,739 (86.8)	85.7–87.8	p<0.001
Military	222 (74.5)	66.1–81.3		263 (92.9)	88.2–95.8	
Public only	1,951 (64.3)	61.4–67.1		2,118 (78.4)	75.9–80.7	
Uninsured	370 (35.3)	29.2–41.9		1,318 (63.8)	60.3–67.2	

Abbreviations: CI = confidence interval; GED = General Educational Development certificate; HPV = human papillomavirus; NA = not applicable; Pap = Papanicolaou.
* Among women aged 50–74 years.
† Pap test for women without hysterectomy either within 3 years for women aged 21–65, or Pap with HPV test within 5 years for women aged 30–65 years.
§ Weighted percentages. Overall percentages presented as crude and age-adjusted estimates; other percentages are crude estimates.
¶ Age-standardized to the 2000 U.S. standard population.
** p-value testing for differences across four primary race groups.
†† p-value testing for differences between Hispanic and non-Hispanics.
§§ Not estimated for these age groups.
¶¶ Relative standard error >30%.

aged 65–75 years (71.8%). Foreign-born persons reported lower use of colorectal cancer screening (52.3% [U.S. residence ≥10 years], 36.3% [U.S. residence <10 years]) than did U.S.-born persons (64.6%). As education and income levels increased, the proportion of persons who received colorectal cancer screening increased. Lowest colorectal cancer screening use was reported by persons without a usual source of health care (26.3%) and persons who were uninsured (25.1%).

Discussion

Cancer screening in the United States remains below HP2020 targets. A previous study of cancer screening using data from the 2013 NHIS found that overall use of screening tests was below HP2020 targets, with no improvements from 2010 to 2013 for breast, cervical, or colorectal cancer (*3*). Based on these more recent data, the overall trend from 2000 to 2015 demonstrates that colorectal cancer screening increased, breast cancer screening was stable, and cervical cancer screening declined slightly. Few subgroups met HP2020 targets in 2015, with many groups remaining far below targets, and disparities in use of cancer screening tests exist based on race, ethnicity, income, and education.

The progress in increasing use of colorectal cancer screening is promising, but more needs to be done if the HP2020 target

TABLE 2. Percentage of adults who received recent colorectal cancer screenings,* by selected sociodemographic characteristics and health care access — National Health Interview Survey, United States, 2015

Characteristic	No. (%†)	95% CI
Overall		
Crude	12,650 (62.4)	61.1–63.7
Age–adjusted§	12,650 (62.4)	61.1–63.8
Race¶,**		
White	10,051 (63.7)	62.2–65.2
Black	1,777 (59.3)	56.0–62.5
American Indian/Alaska Native	160 (48.4)	38.3–58.7
Asian	595 (52.1)	46.7–57.4
Chinese	111 (56.0)	44.5–67.0
Filipino	161 (54.7)	43.2–65.7
Other Asian	323 (49.7)	43.4–56.0
Ethnicity¶,††		
Non-Hispanic	11,163 (64.2)	62.7–65.6
Hispanic	1,487 (47.4)	44.1–50.8
Puerto Rican	192 (63.2)	54.3–71.2
Mexican	501 (36.0)	31.0–41.4
Mexican-American	307 (49.8)	41.9–57.8
Central/South American	240 (52.6)	43.2–61.8
Other Hispanic	247 (51.6)	43.8–59.4
Age group (yrs)¶		
50–64	7,947 (57.9)	56.2–59.6
65–75	4,703 (71.8)	70.0–73.6
Sexual Orientation§§		
Gay	210 (69.3)	60.6–76.8
Straight	12,195 (62.5)	61.1–63.8
Bisexual	49 (59.3)	36.6–78.6
Period of U.S. residence¶		
U.S.-born	10,716 (64.6)	63.1–66.0
In U.S. <10 yrs	133 (36.3)	26.6–47.3
In U.S. ≥10 yrs	1,781 (52.3)	49.3–55.2
Education¶		
Less than high school	1,681 (46.7)	43.5–50.0
High school graduate/GED	3,275 (58.2)	55.9–60.6
Some college/Associate degree	3,896 (63.5)	61.2–65.6
College graduate	3,754 (70.7)	68.7–72.7
Percentage of federal poverty threshold¶		
<139	2,702 (46.9)	44.4–49.5
139–250	2,432 (56.1)	52.9–59.1
251–400	2,455 (62.6)	59.6–65.5
>400	5,060 (70.0)	68.2–71.8
Usual source of health care¶		
None or hospital emergency department	997 (26.3)	22.5–30.4
Has usual source	11,651 (65.2)	63.8–66.6
Health care coverage¶		
Private	7,628 (65.6)	63.9–67.2
Military	702 (77.6)	72.8–81.7
Public only	3,494 (60.1)	57.9–62.2
Uninsured	790 (25.1)	20.9–29.9

Abbreviations: CI = confidence interval; GED = General Educational Development certificate.

* Includes fecal occult blood test within 1 year, sigmoidoscopy within 5 years and fecal occult blood test within 3 years, or colonoscopy within 10 years for persons aged 50–75 years.

† Weighted percentages. Overall percentages presented as crude and age–adjusted estimates; other percentages are crude estimates.

§ Age-standardized to the 2000 U.S. standard population.

¶ p<0.001.

** p-value testing for differences across four primary race groups.

†† p-value testing for differences between Hispanic and non-Hispanics.

§§ p = 0.038.

Summary

What is already known about this topic?

Screening can lead to early detection of breast, cervical and colorectal cancer, when cancers might respond better to treatment, thereby reducing deaths. *Healthy People 2020* (HP2020) set targets for screening based on recommendations from the U.S. Preventive Services Task Force. Screening disparities exist for some groups defined by sociodemographics and access to health care.

What is added by this report?

Since 2013, some progress toward meeting the HP2020 objective for colorectal cancer screening has occurred, but the trend for breast cancer screening has been static, and cervical cancer screening is declining. Disparities in screening persisted by race, ethnicity, education, and income. The uninsured and persons without a usual source of care had screening use far below the HP2020 targets.

What are the implications for public health practice?

Progress toward achieving the HP2020 targets will require implementation of evidence-based interventions to increase cancer screening. Such interventions can be both provider- and patient-oriented. Screening among some racial and ethnic minorities and medically underserved populations is suboptimal and innovative approaches to eliminate these disparities might be needed.

is to be achieved. The lack of progress for breast and cervical cancer screening use highlights the need for more initiatives to reach persons facing barriers to screening. Persons without a usual source of health care and the uninsured had the lowest test use, with the overwhelming majority of the uninsured not up to date with breast and colorectal cancer screening. The Affordable Care Act has helped to reduce such barriers by expanding insurance coverage and eliminating cost sharing, in most insurance plans, for preventive services such as breast, cervical, and colorectal cancer screening rated A and B by the USPSTF.† Further, CDC's Colorectal Cancer Control Program helps states and tribes increase colorectal cancer screening use by reducing some barriers and promoting the use of evidence-based interventions to increase screening (*4*). The National Breast and Cervical Cancer Early Detection Program§ provides free or low-cost screening to medically underserved women.

Mammography use among AI/AN declined from 73.4% in 2013 (*3*) to 56.7% 2015. From 1990 to 2009, breast cancer

† U.S. Preventive Services Task Force (USPSTF) A and B grades are defined as follows: A, USPSTF recommends the service and there is high certainty that the net benefit is substantial; B, USPSTF recommends the service and there is high certainty that the net benefit is moderate, or there is moderate certainty that the net benefit is moderate to substantial. https://www.uspreventiveservicestaskforce.org/Page/Name/grade-definitions.

§ https://www.cdc.gov/cancer/nbccedp.

death rates declined for white women, but increased slightly among AI/AN women (*5*). Reasons for this decline are unclear and warrant further investigation. However, data from this analysis indicate that factors associated with lower mammography use include poverty and lack of insurance coverage or a usual source of health care. In addition, because of the small sample size and unstable estimates for AI/AN women, error cannot be ruled out as a potential explanation for this pattern. Lower mammography use might lead to breast cancer diagnosis at later stages and contribute to racial disparities in mortality. The National Breast and Cervical Cancer Early Detection Program supports 11 AI/AN tribes and tribal organizations to increase screening use in these communities (*4*,*6*).

The findings in this report are subject to at least five limitations. First, the screening questions did not distinguish whether the test was performed for screening or diagnostic purposes; however, a person might be considered effectively screened in either instance. Second, data were self-reported and were not verified by medical records. Third, the overall response rate was 55.2%, and nonresponse bias is possible, despite adjustments for nonresponse. Fourth, sample sizes were small and not age-adjusted for some subgroups. Comparisons of subgroup rates to national targets should be interpreted with caution because targets were based on improvement from the 2008 baseline values for the national age-adjusted rate. In addition, consideration should be given to the fact that targets were designed to be met by 2020, not 2015. Finally, screening recommendations and questions have changed over time. In 2012, screening every 5 years with Pap and HPV tests was added as an option for women aged 30–65 years. It is unclear whether this change might have extended screening intervals for women and thus contributed to the slight decline in cervical cancer screening. Attempts were made to account methodologically for changes in recommendations and questions by using consistent definitions across years. Because hysterectomy status was unknown for 2003, Pap test data for that year were excluded Screening measures for the trend analysis were defined according to the 2000 method, which makes assumptions for cases with only partial timing data (i.e. respondent did not provide enough timing detail to determine if the test came within the recommended time interval). This source of bias results in slightly higher estimates but allows for fair comparisons over time. Accordingly, percentages for 2015 in the trend analysis differ slightly from those reported in the tables.

These findings might inform future activities to increase the use of screening tests as recommended. Some progress has been achieved toward meeting the HP2020 objective for colorectal cancer screening, but the trend for mammography use has remained static, and cervical cancer screening is declining. Substantial disparities persist for some subgroups, including persons without health insurance or a usual source of health care. The National Breast and Cervical Cancer Early Detection Program can provide access to timely breast and cervical cancer screening and diagnostic services for low-income, uninsured, and medically underserved women. For persons with access to health care, evidence-based interventions, such as provider and patient reminders about screening, can increase cancer screening rates (*7*). Innovative approaches are needed to reach some racial and ethnic minorities and medically underserved populations to improve the use of cancer screening test use toward the HP2020 targets.

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Short Sleep Duration by Occupation Group — 29 States, 2013–2014

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The American Academy of Sleep Medicine and the Sleep Research Society have determined that adults require ≥7 hours of sleep per day to promote optimal health (*1*). Short sleep duration (<7 hours per day) has been linked to adverse health outcomes including cardiovascular disease, obesity, diabetes, depression, and anxiety, as well as safety issues related to drowsy driving and injuries (*1*,*2*). Additional research has found that sleep duration varies by characteristics such as race, education, marital status, obesity, and cigarette smoking (*3*). Work-related factors such as job stress, work hours, shift work, and physically demanding work have been found to be associated with sleep duration and quality (*4*–*6*). All of these work factors vary by industry and occupation of employment, and the prevalence of short sleep duration has been shown to vary by broad industry and occupation category (*7*). To provide updated and more detailed information about which occupation groups have the highest prevalences of short sleep duration, CDC analyzed data from currently employed adults surveyed for the 2013 and 2014 Behavioral Risk Factor Surveillance System (BRFSS) in 29 states. Among 22 major occupation groups, the highest prevalences of short sleep duration were among workers in the following five groups: Production (42.9%), Healthcare Support (40.1%), Healthcare Practitioners and Technical (40.0%), Food Preparation and Serving-Related (39.8%), and Protective Service (39.2%). The significant differences among occupation groups in the prevalence of short sleep duration suggest that work-related factors should be further evaluated as they might relate to sleep.

BRFSS is an annual, random-digit–dialed telephone survey of noninstitutionalized, U.S. civilian residents aged ≥18 years. It is conducted by U.S. states and territories to gather data on health-related risk behaviors, chronic illnesses and conditions, and use of health-related services.* The BRFSS questionnaire is composed of a set of core questions that are asked by all states; in addition, states may choose from optional modules on specific subjects or include state-added questions. Twenty-nine states† administered the optional industry and occupation module in 2013 or 2014. Response rates for BRFSS are calculated based on American Association of Public Opinion Research guidelines. The median response rate for all states, territories, and the District of Columbia was 46.4% in 2013 and 47.0% in 2014, whereas the response rates for states included in analyses ranged from 31.1% to 59.2% in 2013 and from 33.0% to 57.6% in 2014.§

To determine occupation, BRFSS participants who were employed for wages, self-employed, or out of work for <1 year were asked, "What kind of work do you do?" Participants' responses were recorded as free text and later coded to one of the 574 U.S. Bureau of Census (2002) occupation numeric codes¶ by an auto-coding system or computer-assisted human coders. Because of the difficulty in reporting results for such a large number of occupations, and to protect participants' privacy, the 574 Bureau of Census codes were grouped into 93 two-digit detailed occupation groups used by CDC's National Center for Health Statistics to code occupations for the National Health Interview Survey,** and these detailed groups were collapsed into the 22 two-digit Standard Occupational Classification System major occupation groups created by the Bureau of Labor Statistics.†† Respondents also were asked, "On average, how many hours of sleep do you get in a 24-hour period?" Responses to this question were dichotomized into ≥7 hours of sleep (sufficient sleep) and <7 hours of sleep (short sleep duration).

Among the 412,829 BRFSS participants in 2013 and 2014, a total of 207,143 (50.2%) were currently employed for wages, self-employed, or out of work for <1 year and were considered for analyses. After excluding 523 respondents (0.3%) who were on active military duty, 249 (0.1%) who were unpaid or retired workers, and 26,750 (12.9%) with insufficient or missing information necessary for occupational coding, the final sample for analyses totaled 179,621 (86.7% of the currently employed respondents). Prevalence of short sleep duration was calculated by the 22 major and 93 detailed occupation groups and adjusted for the following characteristics: age group (18–34 years, 35–44 years, 45–54 years, 55–64 years, and ≥65 years); sex (male or female); race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic

* https://www.cdc.gov/brfss/annual_data/2013/pdf/overview_2013.pdf and https://www.cdc.gov/brfss/annual_data/2014/pdf/overview_2014.pdf.

† States providing data in 2013 and 2014: Illinois, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Oregon, Utah, and Washington. States contributing data only in 2013: California, Florida, Wisconsin, and Wyoming. States contributing data only in 2014: Colorado, Connecticut, Georgia, Idaho, Iowa, North Carolina, Tennessee, and Vermont. Washington and Wyoming's 2013 industry and occupation data are from state-added questions, provided with permission of the two states' BRFSS coordinators.

§ https://www.cdc.gov/brfss/annual_data/2013/pdf/2013_dqr.pdf and https://www.cdc.gov/brfss/annual_data/2014/pdf/2014_dqr.pdf.

¶ https://www.census.gov/people/io/methodology/.

** ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2007/srvydesc.pdf.

†† https://www.bls.gov/soc/major_groups.htm.

other race or multiracial); marital status (married/member of an unmarried couple or divorced/widowed/separated/never married); and education level (less than high school diploma, graduated high school, some college, or college graduate). The adjusted prevalence estimates were obtained using logistic regression. F tests were used as a measure of association to determine statistical significance of the variables. All analyses were weighted to account for the survey design unless otherwise noted.

Overall, 36.5% of currently employed adults reported short sleep duration. The prevalence of short sleep duration among persons in the three youngest age groups was similar (18–34 years [37.7%], 35–44 years [37.6%], and 45–54 years [37.4%]) and lower among persons in the two oldest age groups (45-64 years [33.8%] and ≥65 years [29.2%]). Among persons categorized by other characteristics, the highest prevalences were reported by men (37.5%), non-Hispanic blacks (48.5%), persons with some college education (40.0%), and persons who were divorced, widowed, separated or never married (39.5%) (Table 1).

Among the 22 major occupation groups, the highest prevalences of short sleep duration were among workers in the following five groups: Production (42.9%), Healthcare Support (40.1%), Healthcare Practitioners and Technical (40.0%), Food Preparation and Serving-Related (39.8%), and Protective Service (39.2%). The two major occupation groups with the lowest prevalence of short sleep duration were Education, Training, and Library and Farming, Fishing, and Forestry (both 31.3%) (Table 2).

Within the Protective Service major occupation group, the highest prevalence of short sleep duration was reported in the detailed group of firefighting and prevention workers (45.8%). Within the Healthcare Support major group, the highest prevalences were reported in the detailed group of nursing, psychiatric, and home health aides (43.3%). Among all major occupation groups, the detailed groups with the highest prevalences of short sleep duration were communications equipment operators (58.2%), other transportation workers (54.0%), and rail transportation workers (52.7%). The detailed groups with the lowest prevalences of short sleep duration were air transportation workers (21.4%) and religious workers (22.4%) (Table 2).

For the 29 states, the weighted percentage of currently employed adults in any of the five major occupation groups with the highest prevalence of short sleep duration also was calculated. Among the states, the percentage of currently employed adults working in any of the five major occupation groups with the highest prevalence of short sleep duration ranged from 17.6% (Wyoming) to 26.8% (Mississippi) (Table 3).

Discussion

This study is the first to evaluate short sleep duration by 93 detailed occupation groups and at a multistate level. A previous study using National Health Interview Survey data found that within certain industries, production and transportation and material moving occupations had among the highest prevalences of short sleep duration, a finding that is consistent with the results of this study (*7*). Previous studies have shown that shift workers are more likely to experience disturbed sleep and excessive sleepiness, and to report a significantly higher prevalence of short sleep duration compared with day workers (*6*,*8*). Shift work negatively influences health, by affecting the natural circadian rhythm, leading to irregularities in the sleep-wake cycle (*8*). The five major occupation groups with the highest prevalence of short sleep duration (Production, Healthcare Support, Healthcare Practitioners and Technical, Food Preparation and Serving-Related, and Protective Service) also have some of the highest prevalence rates of alternative shift work, ranging from >35% of Healthcare Practitioners and Technical workers to >50% of Food Preparation and Serving-Related workers (*9*).

Respondents working in detailed occupation groups within the major occupation group of Transportation and Material Moving reported a wide range in prevalences of short sleep duration, from air transportation workers (21%) to other transportation workers (54%). In 2011, the Federal Aviation Administration overhauled commercial airline pilot scheduling to ensure that pilots are rested before flying; this might account for the low prevalence of short sleep duration among air transportation workers.[§§] In contrast, 53% of rail transportation workers reported short sleep duration. Although the Railroad Safety Improvement Act of 2008 mandated changes to the limitations on the number of hours railroad employees work, compliance with the bill is not required until 2018.[¶¶] Shift work and existing occupational regulations likely are important factors to consider regarding the results of this study.

The findings in this report are subject to at least four limitations. First, because BRFSS data are cross-sectional, it is not possible to determine temporal relationships. Second, BRFSS data are self-reported, and are therefore subject to recall and social desirability biases. Among certain occupations where sleep duration has been an issue and hours might be specified by regulation (e.g., transportation), there might be a greater sensitivity to this question and a bias toward reporting sufficient sleep. Third, because the data came from 29 states, the

§§ https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=13273.

¶¶ https://www.fra.dot.gov/eLib/details/L04320.

TABLE 1. Prevalence of short sleep duration (<7 hours of sleep per day) among currently employed adults, by selected characteristics — Behavioral Risk Factor Surveillance System, 29 states, 2013–2014

Characteristic	Unweighted no.	Weighted % of total sample population (95% CI)	Prevalence of short sleep % (95% CI)
Age group (yrs)			
18–34	41,326	32.8 (32.3–33.4)	37.7 (36.6–38.7)
35–44	38,258	22.2 (21.8–22.7)	37.6 (36.4–38.8)
45–54	52,189	23.4 (23.0–23.9)	37.4 (36.4–38.5)
55–64	54,089	16.5 (16.2–16.9)	33.8 (32.7–34.9)
≥65	21,281	5.0 (4.8–5.2)	29.2 (27.3–31.2)
Sex			
Men	98,868	54.8 (54.3–55.3)	37.5 (36.7–38.2)
Women	108,275	45.2 (44.7–45.7)	35.4 (34.6–36.1)
Race/Ethnicity			
White, non-Hispanic	165,130	63.4 (62.8–63.9)	33.5 (32.9–34.0)
Black, non-Hispanic	13,523	11.1 (10.7–11.5)	48.5 (46.8–50.2)
Hispanic	14,656	16.8 (16.4–17.3)	37.8 (36.1–39.5)
Other race or multiracial, non-Hispanic	10,633	8.7 (8.3–9.1)	39.9 (37.2–42.5)
Education			
Less than high school diploma	8,863	10.7 (10.3–11.2)	37.4 (35.3–39.5)
Graduated high school	48,818	24.9 (24.5–25.4)	38.9 (37.8–39.9)
Some college	57,291	31.0 (30.5–31.5)	40.0 (39.0–41.1)
College graduate	91,704	33.3 (32.8–33.8)	31.3 (30.6–32.1)
Marital status			
Married/Member of an unmarried couple	130,990	60.8 (60.3–61.4)	34.7 (34.0–35.3)
Divorced/Widowed/Separated/Never married	74,856	39.2 (38.6–39.7)	39.5 (38.6–40.4)
State of residence			
California	3,706	18.0 (17.6–18.4)	37.3 (35.3–39.4)
Colorado	4,590	2.8 (2.8–2.9)	29.2 (27.4–31.0)
Connecticut	4,257	1.9 (1.8–1.9)	36.3 (34.4–38.3)
Florida	12,982	9.1 (8.9–9.3)	38.9 (37.2–38.3)
Georgia	2,857	4.8 (4.7–4.9)	38.8 (36.5–41.1)
Idaho	2,628	0.8 (0.7–0.8)	32.2 (29.7–34.8)
Illinois	5,403	6.5 (6.4–6.6)	35.9 (34.2–37.6)
Iowa	4,370	1.7 (1.6–1.7)	32.4 (30.6–34.1)
Louisiana	5,449	2.1 (2.1–2.2)	37.4 (35.5–39.2)
Maryland	13,210	3.2 (3.2–3.3)	40.6 (39.2–42.0)
Massachusetts	15,405	3.5 (3.5–3.6)	35.2 (34.1–36.4)
Michigan	9,811	4.6 (4.5–4.7)	40.3 (39.1–41.6)
Minnesota	18,291	3.1 (3.0–3.1)	31.6 (30.5–32.6)
Mississippi	4,735	1.3 (1.3–1.4)	35.9 (34.0–37.9)
Montana	8,729	0.5 (0.5–0.5)	31.1 (29.8–32.5)
Nebraska	11,011	1.0 (1.0–1.0)	32.5 (31.1–34.0)
New Hampshire	6,628	0.7 (0.7–0.7)	32.5 (31.0–34.1)
New Jersey	4,805	4.7 (4.5–4.8)	39.6 (37.5–41.8)
New Mexico	8,571	0.9 (0.9–1.0)	33.1 (31.7–34.6)
New York	3,826	9.8 (9.6–10.1)	40.1 (38.0–42.3)
North Carolina	3,408	4.8 (4.7–4.9)	32.7 (30.8–34.5)
North Dakota	9,082	0.4 (0.4–0.4)	32.0 (30.6–33.5)
Oregon	4,966	1.8 (1.8–1.9)	31.8 (30.1–33.5)
Tennessee	2,073	3.1 (3.0–3.2)	36.4 (33.5–39.3)
Utah	15,806	1.5 (1.4–1.5)	33.9 (32.9–34.8)
Vermont	3,945	0.4 (0.4–0.4)	29.7 (28.0–31.4)
Washington	10,111	3.5 (3.4–3.6)	33.6 (32.4–34.9)
Wisconsin	3,410	2.9 (2.9–3.0)	32.9 (30.5–35.3)
Wyoming	3,078	0.3 (0.3–0.3)	29.2 (27.1–31.4)
Overall	**207,143**	**56.3 (55.9–56.7)**	**36.5 (36.0–37.1)**

Abbreviation: CI = confidence interval.

results might not be representative of the national currently employed population. Finally, misclassification of occupation by respondents, interviewers or coders, although likely rare, is possible.

Short sleep duration among the U.S. working population has been estimated to result in a $411 billion dollar annual cost to the economy, equivalent to 2.28% of the country's gross domestic product (*10*). In addition, among employed persons, 1.2 million working days are lost in the United

TABLE 2. Prevalence of short sleep duration (<7 hours of sleep per day) among currently employed adults, by Standard Occupational Classification (SOC) System major occupation groups and detailed occupation groups* — Behavioral Risk Factor Surveillance System (BRFSS), 29 states, 2013–2014

Major occupation group (SOC code)/Detailed occupation group	Unweighted no.	Unadjusted % (95% CI)	Adjusted[†] % (95% CI)	CV for adjusted %
Production (51)	**7,605**	**44.6 (42.0–47.2)**	**42.9 (40.3–45.4)**	**0.03**
Printing workers	216	52.3 (38.1–66.6)	50.9 (37.1–64.6)	0.14
Plant and system operators	503	52.3 (40.4–64.3)	49.6 (38.7–60.5)	0.11
Supervisors, production workers	546	50.3 (39.9–60.8)	48.9 (39.0–58.9)	0.10
Other production occupations	2,671	47.1 (42.9–51.3)	45.6 (41.5–49.8)	0.05
Metal workers and plastic workers	1,478	45.3 (40.5–50.2)	44.0 (39.2–49.0)	0.06
Woodworkers	199	40.3 (24.2–56.4)	39.2 (25.9–54.4)	0.19
Assemblers and fabricators	811	39.4 (32.2–46.6)	36.8 (29.9–44.2)	0.10
Food processing workers	543	37.9 (28.7–47.1)	35.9 (27.5–45.3)	0.13
Textile, apparel, and furnishings workers	638	34.6 (24.7–44.6)	34.2 (24.9–44.8)	0.15
Healthcare Support (31)	**4,328**	**42.7 (39.4–46.1)**	**40.1 (36.7–43.5)**	**0.04**
Nursing, psychiatric, and home health aides	2,484	47.8 (43.3–52.3)	43.3 (38.9–47.8)	0.05
Other healthcare support occupations	1,732	35.8 (30.6–41.0)	35.7 (30.5–41.3)	0.08
Occupational and physical therapist assistants and aides	112	30.5 (15.8–45.1)	32.8 (19.7–49.4)	0.24
Healthcare Practitioners and Technical (29)	**14,975**	**38.1 (35.9–40.2)**	**40.0 (37.8–42.2)**	**0.03**
Health technologists and technicians	3,218	41.0 (37.2–44.9)	40.4 (36.7–44.3)	0.05
Health diagnosing and treating practitioners	11,589	37.2 (34.7–39.7)	39.7 (37.0–42.4)	0.04
Other healthcare practitioners and technical occupations	168	33.4 (15.6–51.2)	35.1 (21.0–52.6)	0.24
Food Preparation and Serving-Related (35)	**5,413**	**42.4 (39.1–45.6)**	**39.8 (36.6–43.0)**	**0.04**
Supervisors, food preparation, and serving workers	910	53.1 (44.8–61.4)	48.9 (40.6–57.3)	0.09
Cooks and food preparation workers	2,162	44.3 (38.9–49.7)	41.4 (36.3–46.8)	0.07
Food and beverage serving workers	1,876	37.4 (32.4–42.3)	36.1 (31.4–41.1)	0.07
Other food preparation and serving related workers	465	33.0 (23.0–43.1)	30.8 (21.7–41.6)	0.17
Protective Service (33)	**3,462**	**42.4 (38.6–46.2)**	**39.2 (35.6–43.0)**	**0.05**
Firefighting and prevention workers	534	48.0 (39.0–56.9)	45.8 (37.1–54.7)	0.10
Law enforcement officers	1,591	42.2 (36.8–47.7)	39.8 (34.6–45.3)	0.07
Other protective service workers	1,129	41.9 (35.0–48.7)	37.7 (31.4–44.4)	0.09
First-line supervisors/managers, protective service workers	208	26.4 (13.2–39.6)	23.7 (13.0–39.3)	0.28
Transportation and Material Moving (53)	**8,014**	**42.3 (39.7–44.9)**	**39.1 (36.6–41.7)**	**0.03**
Other transportation workers	138	56.5 (39.4–73.7)	54.0 (35.9–71.2)	0.17
Rail transportation workers	227	54.5 (39.2–69.8)	52.7 (37.4–67.4)	0.15
Supervisors, transportation and material moving employees	141	48.0 (29.1–66.9)	43.3 (26.0–62.4)	0.22
Material moving workers	2,337	44.2 (39.5–48.8)	40.5 (36.0–45.1)	0.06
Motor vehicle operators	4,823	41.5 (38.0–44.9)	38.5 (35.2–41.9)	0.04
Water transportation workers	99	30.0 (14.8–45.2)	31.5 (18.4–48.4)	0.25
Air transportation workers	249	20.6 (11.6–29.7)	21.4 (13.3–32.8)	0.23
Personal Care and Service (39)	**5,907**	**38.9 (35.3–42.5)**	**37.5 (34.0–41.1)**	**0.05**
Supervisors, personal care and service workers	153	32.8 (14.5–51.0)	34.3 (17.7–55.9)	0.30
Animal care and service workers	289	34.1 (19.2–48.9)	35.3 (22.0–51.3)	0.22
Entertainment attendants and related workers	219	51.7 (25.1–78.3)	48.2 (27.1–69.9)	0.24
Personal appearance workers	1,114	34.1 (27.3–40.9)	31.7 (25.4–38.9)	0.11
Transportation, tourism, and lodging attendants	236	41.7 (27.6–55.7)	36.4 (25.1–49.4)	0.17
Other personal care and service workers	3,876	39.4 (35.3–43.5)	38.5 (34.4–42.7)	0.05
Funeral service workers	20	—[§]	—	0.18
Installation, Maintenance, and Repair (49)	**5,328**	**38.4 (35.2–41.5)**	**36.6 (33.5–39.8)**	**0.04**
Other installation, maintenance, and repair occupations	1,946	39.9 (34.7–45.2)	38.7 (33.6–44.1)	0.07
Electrical and electronic equipment mechanics, installers, and repairers	713	39.1 (30.4–47.9)	36.6 (28.4–45.7)	0.12
Vehicle and mobile equipment mechanics, installers, and repairers	2,431	37.7 (33.1–42.4)	36.0 (31.6–40.7)	0.06
Supervisors of installation, maintenance, and repair workers	238	27.2 (16.1–38.3)	27.5 (18.0–39.6)	0.20
Office and Administrative Support (43)	**21,406**	**36.6 (34.9–38.3)**	**36.5 (34.8–38.3)**	**0.02**
Communications equipment operators	109	59.0 (43.1–74.9)	58.2 (42.6–72.3)	0.13
Material recording, scheduling, dispatching, and distribution workers	2,584	46.2 (41.1–51.3)	44.6 (39.5–49.9)	0.06
Other office and administrative support workers	5,325	35.7 (32.0–39.3)	36.0 (32.3–39.7)	0.05
Information and record clerks	4,279	36.9 (33.5–40.3)	35.9 (32.5–39.3)	0.05
Financial clerks	3,539	34.8 (30.3–39.3)	35.3 (30.9–40.0)	0.07
Supervisors, office and administrative support workers	2,139	31.6 (27.4–35.9)	33.3 (29.1–37.8)	0.07
Secretaries and administrative assistants	3,431	31.7 (28.1–35.3)	32.4 (29.0–36.1)	0.06
Business and Financial Operations (13)	**7,811**	**33.9 (31.1–36.8)**	**36.1 (33.3–39.0)**	**0.04**
Business operations specialists	3,734	34.7 (30.5–39.0)	36.0 (32.2–40.0)	0.06
Financial specialists	4,077	33.1 (29.2–36.9)	36.0 (32.2–40.0)	0.06
Building and Grounds Cleaning and Maintenance (37)	**6,265**	**38.0 (35.1–40.9)**	**36.0 (33.2–39.0)**	**0.04**
Supervisors, building and grounds cleaning and maintenance workers	415	42.4 (33.7–51.2)	41.2 (33.3–49.6)	0.10
Building cleaning and pest control workers	4,750	40.2 (36.8–43.6)	38.2 (34.8–41.6)	0.04
Grounds maintenance workers	1,100	30.4 (24.1–36.6)	28.8 (23.1–35.3)	0.11

See table footnotes on next page.

TABLE 2. (*Continued*) Prevalence of short sleep duration (<7 hours of sleep per day) among currently employed adults, by Standard Occupational Classification (SOC) System major occupation groups and detailed occupation groups* — Behavioral Risk Factor Surveillance System (BRFSS), 29 states, 2013–2014

Major occupation group (SOC code)/Detailed occupation group	Unweighted no.	Unadjusted % (95% CI)	Adjusted† % (95% CI)	CV for adjusted %
Arts, Design, Entertainment, Sports, and Media (27)	**4,124**	**33.5 (28.7–38.3)**	**35.5 (31.1–40.2)**	**0.06**
Art and design workers	1,569	38.0 (28.6–47.4)	39.0 (31.0–47.7)	0.11
Entertainers and performers, sports and related workers	769	33.7 (23.8–43.6)	34.8 (26.1–44.6)	0.14
Media and communication workers	1,392	29.3 (23.7–34.8)	33.6 (28.1–39.6)	0.09
Media and communication equipment workers	394	28.4 (17.6–39.2)	29.3 (19.6–41.3)	0.19
Management (11)	**21,808**	**33.8 (32.1–35.4)**	**35.4 (33.7–37.2)**	**0.03**
Chief, executives; general and operations managers; legislators	2,529	33.4 (29.4–37.4)	36.3 (32.2–40.6)	0.06
Operations specialties managers	3,167	34.1 (30.3–37.8)	35.6 (31.8–39.6)	0.06
Other management occupations	14,795	34.0 (31.9–36.2)	35.3 (33.0–37.5)	0.03
Advertising, marketing, promotions, public relations, and sales managers	1,317	31.7 (25.8–37.5)	34.1 (28.4–40.3)	0.09
Legal (23)	**2,694**	**31.1 (27.3–34.8)**	**34.5 (30.6–38.5)**	**0.06**
Legal support workers	758	35.9 (28.5–43.2)	37.5 (30.4–45.1)	0.10
Lawyers, judges, and related workers	1,936	29.1 (24.7–33.5)	32.9 (28.3–37.7)	0.07
Construction and Extraction (47)	**9,208**	**36.1 (33.8–38.3)**	**34.5 (32.2–36.9)**	**0.03**
Extraction workers	575	46.0 (36.7–55.3)	45.3 (36.3–54.7)	0.10
Construction trades workers	6,975	36.2 (33.6–38.7)	34.6 (32.0–37.3)	0.04
Other construction and related workers	458	34.3 (23.6–45.0)	34.5 (24.4–46.2)	0.16
Supervisors, construction and extraction workers	1,184	34.4 (28.8–40.1)	34.2 (28.8–40.1)	0.08
Helpers, constructions trades	16	—	—	0.89
Sales and Related (41)	**16,526**	**34.9 (33.0–36.7)**	**34.4 (32.6–36.3)**	**0.03**
Supervisors, sales workers	3,332	36.0 (31.8–40.2)	36.0 (32.0–40.2)	0.06
Sales representatives, services	2,214	33.7 (28.9–38.5)	35.4 (30.7–40.4)	0.07
Retail sales workers	7,243	36.3 (33.4–39.1)	34.4 (31.7–37.3)	0.04
Other sales and related workers	2,408	32.4 (27.3–37.4)	33.5 (28.6–38.8)	0.08
Sales representatives, wholesale and manufacturing	1,329	29.1 (23.8–34.5)	30.3 (25.1–36.1)	0.09
Architecture and Engineering (17)	**4,886**	**32.6 (29.3–35.8)**	**34.3 (31.0–37.9)**	**0.05**
Drafters, engineering, and mapping technicians	847	42.0 (34.1–49.9)	40.5 (33.0–48.5)	0.10
Architects, surveyors, and cartographers	432	33.8 (21.6–46.0)	36.2 (24.6–49.7)	0.18
Engineers	3,607	29.8 (26.2–33.5)	32.2 (28.4–36.3)	0.06
Computer and Mathematical (15)	**5,591**	**33.3 (30.5–36.1)**	**33.8 (31.1–36.7)**	**0.04**
Mathematical science occupations	278	36.8 (25.6–48.0)	38.1 (27.4–50.2)	0.15
Computer specialists	5,313	33.2 (30.3–36.1)	33.6 (30.7–36.6)	0.04
Life, Physical, and Social Science (19)	**3,265**	**30.2 (26.5–34.0)**	**33.6 (29.7–37.7)**	**0.06**
Life, physical, and social science technicians	552	41.3 (32.0–50.6)	41.8 (32.9–51.2)	0.11
Physical scientists	929	28.8 (22.6–35.0)	32.4 (25.9–39.6)	0.11
Social scientists and related workers	970	27.9 (20.3–35.4)	32.3 (24.8–40.9)	0.13
Life scientists	814	23.8 (17.9–29.8)	26.8 (20.9–33.6)	0.12
Community and Social Services (21)	**4,224**	**31.3 (26.9–35.7)**	**32.2 (27.7–37.1)**	**0.07**
Counselors, social workers, and other community and social service specialists	3,322	33.6 (28.5–38.7)	34.0 (28.8–39.7)	0.08
Religious workers	902	20.5 (15.2–25.7)	22.4 (17.2–28.6)	0.13
Education, Training, and Library (25)	**15,249**	**27.9 (26.2–29.7)**	**31.3 (29.2–33.4)**	**0.04**
Postsecondary teachers	2,351	21.8 (18.4–25.3)	25.4 (21.7–29.4)	0.08
Primary, secondary, and special education school workers	9,806	29.0 (26.7–31.2)	32.5 (29.9–35.1)	0.04
Other teachers and instructors	834	23.6 (17.1–30.2)	25.2 (19.0–32.7)	0.14
Librarians, curators, and archivists	628	26.2 (18.5–33.9)	30.3 (22.9–38.8)	0.14
Other education, training, and library occupations	1,630	31.6 (25.8–37.4)	32.5 (26.8–38.8)	0.10
Farming, Fishing, and Forestry (45)	**1,532**	**32.1 (24.5–38.7)**	**31.3 (25.0–38.4)**	**0.11**
Fishing and hunting workers	82	35.1 (16.0–54.2)	36.6 (20.4–56.5)	0.26
Agricultural workers	1,210	31.0 (23.6–38.4)	30.2 (23.1–38.3)	0.13
Forest, conservations, and logging workers	179	—	—	0.31
Supervisors, farming, fishing, and forestry workers	61	—	—	0.41
All occupation groups	**179,621**	**36.5 (35.9–37.1)**	—	—

Abbreviations: CI = confidence interval; CV = coefficient of variation.

* To determine occupation, Behavioral Risk Factor Surveillance System participants who were employed for wages, self-employed, or out of work for <1 year were asked, "What kind of work do you do?" Participants' responses were recorded as free text and later coded to one of the 574 U.S. Bureau of Census (2002) occupation numeric codes by an auto-coding system or computer-assisted human coders. Because of the difficulty in reporting results for such a large number of occupations, and to protect participants' privacy, the 574 Bureau of Census codes were grouped into 93 two-digit detailed occupation groups used by CDC's National Center for Health Statistics to code occupations for the National Health Interview Survey, and these detailed groups were collapsed into the 22 two-digit SOC major occupation groups created by the Bureau of Labor Statistics. Respondents also were asked, "On average, how many hours of sleep do you get in a 24-hour period?" Responses to this question were dichotomized into ≥7 hours of sleep (sufficient sleep) and <7 hours of sleep (short sleep duration).

† Adjusted by sex, race/ethnicity, marital status, age group, and education level.

§ Estimates were suppressed because they did not meet the statistical reliability standards of BRFSS (i.e., cell size was <50 participants or CV >0.30).

States each year because of sleep deprivation. It is estimated that if persons who sleep <6 hours per day began sleeping for 6–7 hours per day, approximately $226 billion could be added to the U.S. economy (*10*). A goal of *Healthy People 2020* is to "increase public knowledge of how adequate sleep and treatment of sleep disorders improve health, productivity, wellness, quality of life, and safety on roads and in the workplace," with a specific objective to increase the proportion of adults getting sufficient sleep.***

CDC's National Institute for Occupational Safety and Health has developed educational resources on shift work and long working hours for managers, workers, and the public.††† The materials include interactive training for nurses, emergency responders, and truck drivers, as well as information for aviation and railroad employees, methods for improving shiftwork schedules, and individual coping strategies. Time at work continues to increase, with the United States having the longest annual working hours among all wealthy industrialized countries (*7*). Job characteristics, such as schedules, stress, and physical output, should be evaluated in an effort to improve worker sleep duration and overall health.

*** https://www.healthypeople.gov/2020/topics-objectives/topic/sleep-health.
††† https://www.cdc.gov/niosh/topics/workschedules/education.html.

Acknowledgments

Aaron Sussell, Sara Luckhaupt, Jan Birdsey, Jeff Purdin, Pam Schumacher, Susan Burton, Division of Surveillance, Hazard Evaluations, and Field Studies, National Institute for Occupational Safety and Health, CDC; 29 Behavioral Risk Factor Surveillance System state coordinators.

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TABLE 3. Weighted percentage of currently employed adults in the five major occupation groups of the Standard Occupational Classification System with the highest prevalence of short sleep duration (<7 hours of sleep per day), by state — Behavioral Risk Factor Surveillance System, 29 states, 2013–2014

	Top five major occupation groups					
State	Production	Healthcare Support	Healthcare Practitioners and Technical	Food Preparation and Serving-Related	Protective Service	Any of the top five major occupation groups
Mississippi	7.7	2.5	8.2	5.2	3.2	26.8
Tennessee	8.0	2.6	6.6	5.6	2.5	25.3
Wisconsin	10.1	3.1	6.2	3.9	2.0	25.3
Louisiana	4.8	3.3	7.7	6.2	3.0	25.0
Michigan	8.1	3.2	7.4	4.2	1.9	24.8
North Carolina	5.7	3.1	7.2	4.2	2.5	22.7
Iowa	7.5	3.2	7.0	3.1	1.5	22.3
New York	3.9	3.1	8.0	4.8	2.5	22.3
Illinois	6.5	3.0	6.3	4.4	1.9	22.1
Minnesota	6.1	2.8	8.1	3.9	1.2	22.1
Oregon	5.8	2.5	6.8	4.1	2.5	21.7
Massachusetts	3.7	2.8	9.6	3.6	1.8	21.5
Florida	3.2	3.0	6.8	5.4	3.1	21.5
Vermont	6.0	2.4	6.9	4.5	1.6	21.4
Connecticut	4.7	3.0	8.0	3.4	2.3	21.4
Nebraska	6.0	2.6	7.3	3.8	1.6	21.3
North Dakota	5.0	2.8	6.8	4.3	1.9	20.8
Idaho	5.9	2.7	5.1	4.4	2.4	20.5
New Hampshire	4.7	3.1	7.6	3.1	1.7	20.2
Montana	4.8	2.5	5.8	4.4	2.4	19.9
California	5.1	1.7	5.4	5.0	2.1	19.3
New Jersey	3.2	2.9	7.6	2.4	3.2	19.3
Washington	4.6	2.6	6.0	4.2	1.8	19.2
New Mexico	3.6	2.6	6.2	3.8	2.9	19.1
Georgia	5.2	1.6	5.6	4.6	1.8	18.8
Maryland	1.9	2.3	6.9	4.2	3.5	18.8
Utah	5.2	2.4	5.6	3.3	2.2	18.7
Colorado	3.6	2.2	6.0	4.2	2.5	18.5
Wyoming	5.2	1.7	5.2	3.2	2.3	17.6

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Summary

What is already known about this topic?

Shift work and other work factors influence sleep duration and sleep quality, which have a direct effect on worker health and safety. Previous research has found that workers in production, health care, protective service, transportation and material moving, and food preparation and serving-related fields are more likely to be shift workers. In addition, production and transportation and material moving occupations have been associated with higher prevalences of short sleep duration.

What is added by this report?

Analysis of 2013 and 2014 Behavioral Risk Factor Surveillance System data conducted to examine 93 detailed occupation groups in 29 states found that the prevalence of <7 hours of sleep per day (short sleep duration) ranged from 21.4% among air transportation workers to 58.2% among communications equipment workers. The percentage of workers employed in at least one of the five occupations with the highest prevalence of short sleep duration ranged from 17.6% in Wyoming to 26.8% in Mississippi.

What are the implications for public health practice?

Significant differences were found in the prevalence of short sleep duration among occupation groups. Workers in occupations with high prevalences of short sleep duration might be most at risk for sleep-related accidents and adverse health outcomes associated with short sleep duration. Work-related factors should be further evaluated in the context of short sleep duration to guide prevention efforts.

Malignant Mesothelioma Mortality — United States, 1999–2015

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Malignant mesothelioma is a neoplasm associated with occupational and environmental inhalation exposure to asbestos* fibers and other elongate mineral particles (EMPs) (*1*–*3*). Patients have a median survival of approximately 1 year from the time of diagnosis (*1*). The latency period from first causative exposure to malignant mesothelioma development typically ranges from 20 to 40 years but can be as long as 71 years (*2*,*3*). Hazardous occupational exposures to asbestos fibers and other EMPs have occurred in a variety of industrial operations, including mining and milling, manufacturing, shipbuilding and repair, and construction (*3*). Current exposures to commercial asbestos in the United States occur predominantly during maintenance operations and remediation of older buildings containing asbestos (*3*,*4*). To update information on malignant mesothelioma mortality (*5*), CDC analyzed annual multiple cause-of-death records† for 1999–2015, the most recent years for which complete data are available. During 1999–2015, a total of 45,221 deaths with malignant mesothelioma mentioned on the death certificate as the underlying or contributing cause of death were reported in the United States, increasing from 2,479 deaths in 1999 to 2,597 in 2015 (in the same time period the age-adjusted death rates§ decreased from 13.96 per million in 1999 to 10.93 in 2015). Malignant mesothelioma deaths increased for persons aged ≥85 years, both sexes, persons of white, black, and Asian or Pacific Islander race, and all ethnic groups. Despite regulatory actions and the decline in use of asbestos the annual number of malignant mesothelioma deaths remains substantial. The continuing occurrence of malignant mesothelioma deaths underscores the need for maintaining measures to prevent exposure to asbestos fibers and other causative EMPs and for ongoing surveillance to monitor temporal trends.

For this report, malignant mesothelioma deaths during 1999–2015 were identified from death certificates and included deaths for which *International Classification of Diseases (ICD), 10th Revision* codes for malignant mesothelioma¶ were listed as either the underlying or contributing cause of death in the multiple cause-of-death mortality data. The analysis was restricted to deaths of persons aged ≥25 years, as they were more likely to have been occupationally exposed than were younger decedents. Age-adjusted death rates per 1 million persons aged ≥25 years by demographics, neoplasm anatomical site, and year were calculated using the 2000 U.S. Census standard population estimate. Industry and occupation information was available from death certificates for decedents reported from 23 states for 1999, 2003, 2004, and 2007, and was coded** using the U.S. Census 2000 Industry and Occupation Classification System. Proportionate mortality ratios (PMRs)†† for malignant mesothelioma by industry and occupation were calculated. Confidence intervals (CIs) were calculated assuming Poisson distribution of the data.

During 1999–2015, a total of 45,221 deaths with malignant mesothelioma mentioned on the death certificate as the underlying or contributing cause of death among persons aged ≥25 years were reported in the United States; 16,914 (37.4%) occurred among persons aged 75–84 years, 36,093 (79.8%) occurred among males, 42,778 (94.6%) among whites, and 43,316 (95.8%) among non-Hispanics (Table 1). Malignant mesothelioma was classified as mesothelioma of pleura (3,351; 7.4%), peritoneum (1,854; 4.1%), pericardium (74; 0.2%), other anatomic site (5,280; 11.7%), and unspecified anatomic site (35,068; 77.5%). Among 42,470 (93.9%) decedents, malignant mesothelioma was coded as the underlying§§ cause of death.

* "Asbestos" is a term used for certain minerals that have crystallized in a particular macroscopic habit with certain commercially useful properties. "Asbestiform" is a term applied to minerals with a macroscopic habit similar to that of asbestos. https://www.cdc.gov/niosh/docs/2011-159/pdfs/2011-159.pdf.

† CDC WONDER. https://wonder.cdc.gov/.

§ Age-adjusted death rates were calculated by applying age-specific death rates to the 2000 U.S. Census standard population age distribution. https://wonder.cdc.gov/wonder/help/mcd.html#Age-Adjusted Rates.

¶ ICD-10 codes C45.0 (mesothelioma of pleura), C45.1 (mesothelioma of peritoneum), C45.2 (mesothelioma of pericardium), C45.7 (mesothelioma of other sites), and C45.9 (mesothelioma, unspecified). The death counts reported are the number of times each specific cause of death is mentioned in the record, or "any mention" of the specified cause of death. Up to 20 causes can be indicated on any single death certificate.

** https://webappa.cdc.gov/ords/norms.html.

†† PMR was defined as the observed number of deaths with malignant mesothelioma in a specified industry/occupation, divided by the expected number of deaths with malignant mesothelioma. The expected number of deaths was the total number of deaths in industry or occupation of interest multiplied by a proportion defined as the number of malignant mesothelioma deaths in all industries and/or occupations, divided by the total number of deaths in all industries/occupations. The malignant mesothelioma PMRs were internally adjusted by 5-year age groups, gender, and race.

§§ Underlying cause of death is defined as the disease or injury that initiated the chain of morbid events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury.

TABLE 1. Malignant mesothelioma deaths and age-adjusted rates* among decedents aged ≥25 years, by selected characteristics — United States, 1999–2015

Characteristics	No. of deaths	Death rate
Total	**45,221**	**13.10**
Underlying[†] cause	42,470	12.30
Age group (yrs)[§]		
25–34	138	0.20
35–44	544	0.75
45–54	1,936	2.69
55–64	6,237	11.22
65–74	12,985	36.31
75–84	16,914	76.28
≥85	6,467	74.46
Sex		
Male	36,093	24.94
Female	9,128	4.65
Race		
White	42,778	14.25
Black or African American	1,870	5.84
Asian or Pacific Islander	440	3.52
American Indian or Alaska Native	133	5.96
Ethnicity		
Hispanic	1,815	7.38
Non-Hispanic	43,316	13.46
Unknown	90	—
Anatomic site[¶]		
Pleura	3,351	0.98
Peritoneum	1,854	0.51
Pericardium	74	0.01
Other	5,280	1.52
Unspecified	35,068	10.14
Year		
1999	2,479	13.96
2000	2,529	14.16
2001	2,504	13.77
2002	2,570	13.92
2003	2,621	13.95
2004	2,656	13.94
2005	2,701	13.93
2006	2,586	13.19
2007	2,603	12.98
2008	2,706	13.26
2009	2,752	13.20
2010	2,744	13.10
2011	2,829	13.16
2012	2,873	12.97
2013	2,686	11.80
2014	2,785	11.98
2015	2,597	10.93
P-value**	0.001	<0.001

* Age-adjusted death rates per 1 million persons calculated using the 2000 Standard population.

† Underlying cause of death is defined as "the disease or injury which initiated the chain of morbid events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury."

§ Age-specific death rates per 1 million persons.

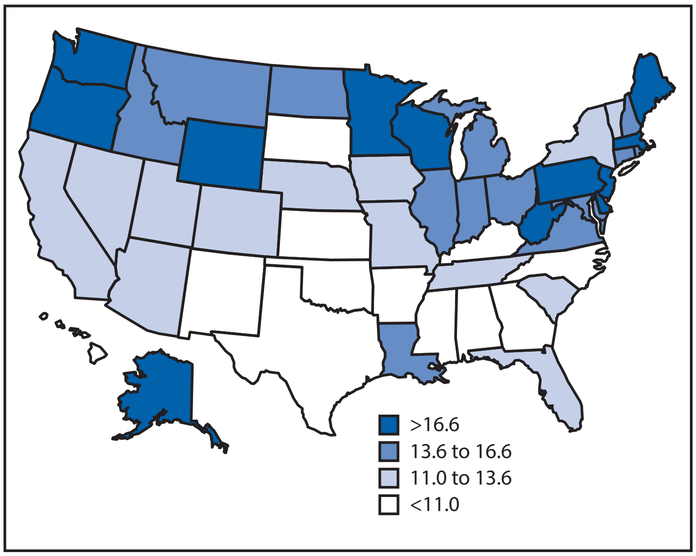
¶ The sum of anatomic site totals (45,627) is greater than the total number of deaths (45,221) because some decedents have more than one site listed on their death certificate.

** For 1999–2015, linear time trend was examined using a first-order autoregressive linear regression model to account for the serial correlation.

During 1999–2015, the annual number of malignant mesothelioma deaths increased 4.8% overall, from 2,479 in 1999 to 2,579 in 2015 (p-value for linear time trend <0.001). The number of malignant mesothelioma deaths increased among persons aged ≥85 years, both sexes, white, black, and Asian or Pacific Islander race, and all ethnic groups; and patients with mesothelioma of the peritoneum and unspecified anatomic site. Malignant mesothelioma deaths decreased among persons aged 35–44, 45–54, and 55–64 years, and among persons with mesothelioma of the pleura and other anatomic sites.

During 1999–2015, the mesothelioma age-adjusted death rate decreased 21.7% from 13.96 per million population (1999) to 10.93 (2015) (p-value for time trend <0.001). This trend in the standardized rate is a weighted average of the trends in the age-specific rates and masks the differences in individual age groups. The age-specific death rate decreased significantly among persons 45–54 (p<0.001), 55–64 (p<0.001), and 65–74 (p<0.001) years and increased significantly among persons aged ≥85 years (p<0.001). During 1999–2015, the annualized state mesothelioma age-adjusted death rate exceeded 20 per million per year in two states: Maine (22.06) and Washington (20.10) (Figure).

FIGURE. Malignant mesothelioma annualized age-adjusted death rate* per 1 million population aged ≥25 years,[†] by state — United States, 1999–2015



* Age-adjusted death rates were calculated by applying age-specific death rates to the 2000 U.S standard population age distribution (https://wonder.cdc.gov/wonder/help/mcd.html#Age-Adjusted Rates). In two states (Maine and Washington), the age-adjusted death rate exceeded 20 per million per year.

† Decedents aged ≥25 years for whom the *International Classification of Diseases, 10th Revision* codes C45.0 (mesothelioma of pleura), C45.1 (mesothelioma of peritoneum), C45.2 (mesothelioma of pericardium), C45.7 (mesothelioma of other sites), or C45.9 (mesothelioma, unspecified) were listed on death certificates were identified using CDC multiple cause-of-death data for 1999–2015.

Industry and occupation data were available for 1,830 (96.3%) of 1,900 malignant mesothelioma deaths that occurred in residents of 23 states during 1999, 2003, 2004, and 2007 (Table 2).¶¶ Among 207 industries and 274 occupations, significantly elevated PMRs for malignant mesothelioma were found for 11 industries and 17 occupations. By industry, the highest PMRs were for ship and boat building and repairing (6.7; 95% CI = 4.3–9.9); petroleum refining (4.1; CI = 2.6–6.0); and industrial and miscellaneous chemicals (3.8; CI = 2.9–5.0). By occupation, the highest PMRs were for insulation workers (26.9; CI = 16.2–42.0); chemical technicians (4.9; CI = 2.1–9.6); and pipelayers, plumbers, pipefitters, and steamfitters (4.8; CI = 3.7–6.1).

Discussion

The annual number of malignant mesothelioma deaths is increasing, particularly among persons aged ≥85 years, most likely representing exposure many years ago. However, although malignant mesothelioma deaths decreased in persons aged 35–64 years, the continuing occurrence of mesothelioma deaths among persons aged <55 years suggests ongoing occupational and environmental exposures to asbestos fibers and other causative EMPs, despite regulatory actions by the Occupational Safety and Health Administration (OSHA)*** and the Environmental Protection Agency††† aimed at limiting asbestos exposure. OSHA established a permissible exposure limit for asbestos of 12 fibers per cubic centimeter (f/cc) of air as an 8-hour time-weighted average in 1971. This initial permissible exposure limit was reduced to 5 f/cc in 1972, 2 f/cc in 1976, 0.2 f/cc in 1986, and 0.1 f/cc in 1994 (*6*). Although

¶¶ For 70 residents of these 23 states, deaths have occurred in states that did not provide the industry and occupation information to the National Institute for Occupational Safety and Health.

*** U.S. Department of Labor. OSHA. Asbestos. OSHA Standards (29 CFR 1910, 1915, and 1926). https://www.osha.gov/SLTC/asbestos/standards.html.

††† U.S. Environmental Protection Agency (EPA). Asbestos Laws and Regulations (https://www.epa.gov/asbestos/asbestos-laws-and-regulations) and EPA Asbestos Materials Bans: Clarification. May 18, 1999 (http://www.ewg.org/asbestos/documents/pdf/asb-bans2.pdf). On July 12, 1989, EPA issued a final rule banning most asbestos-containing products. In 1991, many aspects of this standard were set aside by the U.S. Fifth Circuit Court of Appeals. The following specific asbestos-containing products remain banned: flooring felt, rollboard, and corrugated, commercial, or specialty paper (58 Federal Register 58964). In addition, the regulation continues to ban the use of asbestos in products that have not historically contained asbestos, otherwise referred to as "new uses" of asbestos. Asbestos-containing product categories no longer subject to the 1989 ban include asbestos-cement corrugated sheet, asbestos-cement flat sheet, asbestos clothing, pipeline wrap, roofing felt, vinyl-asbestos floor tile, asbestos-cement shingle, millboard, asbestos-cement pipe, automatic transmission components, clutch facings, friction materials, disc brake pads, drum brake linings, brake blocks, gaskets, non-roofing coatings, and roof coatings.

TABLE 2. Industries and occupations with significantly elevated proportionate mortality ratios, 1,830 malignant mesothelioma decedents aged ≥25 years — 23 states,* 1999, 2003, 2004, and 2007

Characteristic	No. of deaths	PMR† (95% CI)
Industry		
Ship and boat building	24	6.7 (4.3–9.9)
Petroleum refining	25	4.1 (2.6–6.0)
Industrial and miscellaneous chemicals	58	3.8 (2.9–5.0)
Labor unions	7	3.7 (1.5–7.6)
Miscellaneous nonmetallic mineral product manufacturing	5	3.6 (1.2–8.4)
Electric and gas and other combinations	7	3.1 (1.3–6.5)
Water transportation	12	2.3 (1.2–3.9)
Electric power generation transmission and distribution	24	2.2 (1.4–3.3)
U.S. Navy	11	2.0 (1.0–3.6)
Architectural, engineering, and related services	23	1.9 (1.2–2.8)
Construction	280	1.6 (1.4–1.8)
Unknown	42	—
All other industries	1,312	—
Occupation		
Insulation workers	19	26.9 (16.2–42.0)
Chemical technicians	8	4.9 (2.1–9.6)
Pipelayers, plumbers, pipefitters, and steamfitters	67	4.8 (3.7–6.1)
Chemical engineers	12	4.0 (2.1–7.1)
Sheet metal workers	17	3.5 (2.0–5.5)
Sailors and marine oilers	5	3.4 (1.1–8.0)
Structural iron and steel workers	10	3.3 (1.6–6.0)
Millwrights	14	3.1 (1.7–5.2)
Stationary engineers and boiler operators	15	2.9 (1.6–4.8)
Electricians	53	2.8 (2.1–3.7)
Welding, soldering, and brazing workers	30	2.1 (1.4–3.0)
Construction managers	37	2.0 (1.4–2.8)
Engineers, all other	12	2.0 (1.0–3.5)
Mechanical engineers	14	1.9 (1.0–3.2)
First-line supervisors or managers of mechanics, installers, and repairers	27	1.8 (1.2–2.6)
Machinists	39	1.6 (1.1–2.1)
First-line supervisors or managers of production and operating workers	40	1.4 (1.0–2.0)
Unknown	49	—
All other occupations	1,362	—

Abbreviations: CI = confidence interval; PMR = proportionate mortality ratio.

* Multiple cause-of-death mortality files. https://webappa.cdc.gov/ords/norms-io14.html.

† PMR is defined as the observed number of deaths with malignant mesothelioma in a specified industry/occupation, divided by the expected number of deaths with malignant mesothelioma. The expected number of deaths is the total number of deaths in industry or occupation of interest multiplied by a proportion defined as the number of malignant mesothelioma deaths in all industries and/or occupations, divided by the total number of deaths in all industries/occupations. The malignant mesothelioma PMRs were internally adjusted by five-year age groups, gender, and race. CIs were calculated assuming Poisson distribution of the data.

inspection data during 1979–2003 indicated a general decline in the proportion of samples exceeding designated occupational exposure limits, 20% of air samples collected in the construction industry in 2003 for compliance purposes exceeded the OSHA permissible exposure limit. Moreover, asbestos products remain in use, and new asbestos-containing products continue to be manufactured in or imported[§§§] into the United States. Although most deaths from malignant mesothelioma in the United States are the result of exposures to asbestos 20–40 years prior, new cases might result from occupational exposure to asbestos fibers during maintenance activities, demolition and remediation of existing asbestos in structures, installations, and buildings if controls are insufficient to protect workers. The OSHA asbestos standard describes engineering and work practice controls (e.g., use of wet methods, local exhaust ventilation, and vacuum cleaners equipped with high-efficiency particulate air [HEPA] filters) during asbestos handling, mixing, removal, cutting, application, and cleanup and requires the use of respiratory protection if these controls are not sufficient to reduce employee exposure to levels at or below the permissible limit. Moreover, family members of workers engaged in activities placing them at risk for asbestos exposures also have the potential for exposure to asbestos (*3*). In addition, ongoing research is focusing on the potential nonoccupational and environmental exposures to asbestos fibers and other EMPs (e.g., erionite, a naturally occurring fibrous mineral that belongs to a group of minerals called zeolites), and nonmineral elongate particles (e.g., carbon nanotubes) to assess exposures and potential health risks (*7*,*8*).

Among the 96.3% of deaths in 23 states for which industry and occupation were known, shipbuilding and construction industries were major contributors to malignant mesothelioma mortality (*4*). The large number of deaths among construction workers is consistent with large number of construction workers with prior direct and indirect exposure to asbestos fibers through most of the 20th century (the construction industry accounted for 70%–80% of asbestos consumption) (*4*). For example, direct exposure to asbestos has occurred during installation of asbestos-cement pipes, asbestos-cement sheets, architectural panels, built-up roofing, and removal of roofing felts or asbestos insulation. Workers also might have been exposed to asbestos during spraying of asbestos insulation in multistoried structures during 1958–1972 (asbestos-containing materials were banned for fireproofing/insulating in 1973) (*4*). In addition, workers in other occupations (e.g., carpenters, electricians, pipefitters, plumbers, welders) might also have been exposed if they were present on-site during spraying activities.

A review of studies projecting the number of deaths from asbestos-related malignant mesothelioma in the United States indicated that the number of deaths during 1985–2009 would range from 620 to 3,270 annually (*9*). Based on an estimated 27.5 million workers with some exposure to asbestos during 1940–1972, a 1982 study estimated that the number of malignant mesothelioma deaths would rise to 3,060 annually by 2001–2005 (*4*). After 2005, mortality was projected to decrease but would continue for three decades. Based on asbestos consumption and malignant mesothelioma incidence data, it was estimated that the number of mesothelioma cases among males would peak during 2000–2004 (approximately 2,000 cases) and after that period, the number of mesothelioma cases was expected to decline and return to background levels by 2055 (*10*). The number of mesothelioma cases among females (approximately 560 in 2003) was projected to increase slightly over time. The results of the current study indicate an increase in the number of malignant mesothelioma deaths during 1999–2015. This discrepancy might be explained, in part, by the methodology of the projection studies, which were based on multiple assumptions including variations in the number of employed workers at risk, exposure levels and timing, and the linear dose–response relationship between asbestos exposure[¶¶¶] and malignant mesothelioma. Moreover, additional persons who might have been exposed to asbestos and be at risk for malignant mesothelioma (e.g., family contacts of asbestos-exposed workers, persons exposed to naturally occurring asbestos, persons exposed to asbestos in surfacing materials or as fireproofing material in buildings) were not considered (*4*,*10*).

The findings in this report are subject to at least five limitations. First, information on exposure to asbestos or a specific work history was not available to assess the potential source of exposure. The industry and occupation listed on a death certificate might not be the industry and occupation in which the decedent's exposures occurred. Second, the state issuing a death certificate might not be the state or country in which the

§§§ In the United States, approximately 340 metric tons of asbestos were imported in 2016; nearly all asbestos was used by the chloralkali industry to manufacture semipermeable diaphragms. An unknown quantity of asbestos was imported within manufactured products, including brake linings and pads, building materials, gaskets, millboard, and yarn and thread, among others (Flanagan DM. U.S. Geological Survey, 2017, Mineral Commodity Summaries. Asbestos. https://minerals.usgs.gov/minerals/pubs/mcs/2017/mcs2017.pdf).

¶¶¶ Malignant mesothelioma can develop after short-term asbestos exposures of only a few weeks, and from very low levels of exposure. There is no evidence of a threshold level below which there is no risk for mesothelioma. The risk for mesothelioma increases with intensity and duration of asbestos exposure.

decedent's exposures occurred. Third, malignant mesothelioma did not have a discrete ICD code until the 10th revision of the ICD; thus, evaluation of mortality trends before 1999 was not possible. Fourth, some mesothelioma cases might not be included in this analysis because of misdiagnosis and the use of incorrect ICD-10 codes (*1*). Finally, information on decedents' industry and occupation was available only for selected states of residence and years, and might not be nationally representative.

Despite regulatory actions and the decline in use of asbestos, the annual number of malignant mesothelioma deaths remains substantial. Effective asbestos exposure prevention strategies for employers recommended by OSHA and CDC's National Institute for Occupational Safety and Health (https://www.cdc.gov/niosh/topics/asbestos/) are available. The continuing occurrence of malignant mesothelioma deaths underscores the need for maintaining asbestos exposure prevention efforts and for ongoing surveillance to monitor temporal trends.

Acknowledgments

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Summary

What is already known about this topic?

Malignant mesothelioma is a neoplasm associated with inhalation exposure to asbestos fibers and other elongate mineral particles (EMPs). The median survival after malignant mesothelioma diagnosis is approximately 1 year. The latency period between the first exposure to asbestos fibers or other EMPs and mesothelioma development ranges from 20 to 71 years. Occupational exposure has occurred in industrial operations including mining and milling, manufacturing, shipbuilding and repair, and construction. Current occupational exposure occurs predominantly during maintenance and remediation of asbestos-containing buildings. The projected number of malignant mesothelioma deaths was expected to increase to 3,060 annually by 2001–2005, and after 2005, mortality was projected to decrease.

What is added by this report?

During 1999–2015, a total of 45,221 malignant mesothelioma deaths were reported, increasing from 2,479 (1999) to 2,597 (2015). Mesothelioma deaths increased for persons aged ≥85 years, for both sexes, persons of white, black and Asian or Pacific Islander race, and all ethnic groups. Continuing occurrence of malignant mesothelioma deaths in persons aged <55 years suggests ongoing inhalation exposure to asbestos fibers and possibly other causative EMPs.

What are the implications for public health practice?

Despite regulatory actions and decline in asbestos use, the annual number of malignant mesothelioma deaths remains substantial. Contrary to past projections, the number of malignant mesothelioma deaths has been increasing. The continuing occurrence of mesothelioma deaths, particularly among younger populations, underscores the need for maintaining efforts to prevent exposure and for ongoing surveillance to monitor temporal trends.

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Baseline Prevalence of Birth Defects Associated with Congenital Zika Virus Infection — Massachusetts, North Carolina, and Atlanta, Georgia, 2013–2014

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Zika virus infection during pregnancy can cause serious brain abnormalities, but the full range of adverse outcomes is unknown (*1*). To better understand the impact of birth defects resulting from Zika virus infection, the CDC surveillance case definition established in 2016 for birth defects potentially related to Zika virus infection* (*2*) was retrospectively applied to population-based birth defects surveillance data collected during 2013–2014 in three areas before the introduction of Zika virus (the pre-Zika years) into the World Health Organization's Region of the Americas (Americas) (*3*). These data, from Massachusetts (2013), North Carolina (2013), and Atlanta, Georgia (2013–2014), included 747 infants and fetuses with one or more of the birth defects meeting the case definition (pre-Zika prevalence = 2.86 per 1,000 live births). Brain abnormalities or microcephaly were the most frequently recorded (1.50 per 1,000), followed by neural tube defects and other early brain malformations† (0.88), eye abnormalities without mention of a brain abnormality (0.31), and other consequences of central nervous system (CNS) dysfunction without mention of brain or eye abnormalities (0.17). During January 15–September 22, 2016, the U.S. Zika Pregnancy Registry (USZPR) reported 26 infants and fetuses with these same defects among 442 completed pregnancies (58.8 per 1,000) born to mothers with laboratory evidence of possible Zika virus infection during pregnancy (*2*). Although the ascertainment methods differed, this finding was approximately 20 times higher than the proportion of one or more of the same birth defects among pregnancies during the pre-Zika years. These data demonstrate the importance of population-based surveillance for interpreting data about birth defects potentially related to Zika virus infection.

Statewide data from birth defects surveillance programs in Massachusetts and North Carolina for 2013 and from a surveillance program in three counties in metropolitan Atlanta, Georgia, for 2013–2014 were chosen for analysis because these programs conducted population-based surveillance for all types of birth defects, used active multisource case-finding, and were rapidly able to provide individual-level data with sufficient detail to apply all inclusion and exclusion criteria (*4*). Trained staff members in these surveillance programs routinely reviewed the medical records of infants and fetuses with birth defects and abstracted information about those defects, related diagnostic procedures, and demographic and pregnancy information. Included were all infants and fetuses who were identified through surveillance with a birth defect characterized by CDC subject matter experts as being consistent with those observed in cases of congenital Zika virus infection (*2*). Additional data collected included the pregnancy outcome (live birth or pregnancy loss), maternal age, gestational age at delivery, and verbatim clinical descriptions of all birth defects, including genetic abnormalities. These verbatim descriptions were reviewed by CDC subject matter experts to verify the case definition and categorization. The earliest age that a birth defect meeting the definition was noted (i.e., prenatally, ≤28 days after delivery, 29 days to <3 months after delivery, ≥3 to <6 months after delivery, and ≥6 months after delivery) was available for data from Massachusetts and Atlanta.

Infants or fetuses with birth defects were aggregated into four mutually exclusive categories of defects characterized by CDC subject matter experts as being consistent with those observed with congenital Zika virus infection: 1) brain abnormalities or microcephaly (head circumference at delivery <3rd percentile for sex and gestational age) (*5*); 2) neural tube defects and other early brain malformations; 3) eye abnormalities without mention of a brain abnormality included in the first two categories; and 4) other consequences of CNS dysfunction, specifically joint contractures and congenital sensorineural deafness, without mention of brain or eye abnormalities included in another category. Baseline prevalence per 1,000 live births (*6*) and 95% confidence intervals (CIs) were estimated using Poisson regression.

* The Zika surveillance case definition covers all birth defects that have been reported as potentially related to Zika virus infection and includes brain abnormalities such as microcephaly, intracranial calcifications, fetal brain disruption sequence, abnormal cortical formation, and porencephaly, among others; neural tube defects and other early brain malformations, such as anencephaly, spina bifida, encephalocele, and holoprosencephaly; eye abnormalities, such as microphthalmia/anophthalmia, cataracts, chorioretinal and optic nerve abnormalities, among others; and consequences of central nervous system dysfunction, such as joint contractures and congenital sensorineural deafness.

† 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 defects in the other categories.

The three birth defects surveillance programs identified 747 infants and fetuses during 2013 (North Carolina and Massachusetts) and 2013–2014 (Atlanta) with one or more defects that met the 2016 CDC Zika surveillance case definition (2.86 per 1,000 live births [CI = 2.65–3.07]) (Table). Brain abnormalities or microcephaly accounted for the largest number (392 [52%]) and highest prevalence (1.50 per 1,000), followed by neural tube defects and other early brain malformations (229 [31%]; 0.88). Eye abnormalities without mention of a brain abnormality (81 [11%]; 0.31) and consequences of CNS dysfunction without mention of brain or eye abnormalities (45 [6%]; 0.17) were less frequent. Pregnancy losses (48%) and preterm delivery (<37 weeks' gestation) (66%) occurred most frequently with neural tube defects and other early brain malformations. In contrast, all infants with eye abnormalities without mention of a brain abnormality were liveborn.

In general, the distribution by maternal age was similar across birth defect categories. Among 410 (55%) infants or fetuses with information on the earliest age a birth defect was recorded, 371 (90%) had evidence of a birth defect meeting the Zika definition before age 3 months. More than half of those with brain abnormalities or microcephaly or with neural tube defects and other early brain malformations had evidence of these defects noted prenatally (55% and 89%, respectively).

Discussion

A congenital Zika syndrome phenotype has been described (*7*); however, the birth defects observed are not unique to congenital Zika virus infection, and the full range of effects of congenital Zika infection is not known. The data in this report provide a baseline reference for the prevalence of defects observed with congenital Zika virus infection in the pre-Zika years and demonstrate the importance of data on birth defects prevalence in providing a context within which to assess the impact of teratogenic exposures such as Zika virus infection. Recently published data from the USZPR reported 26 infants and fetuses with these same birth defects among 442 completed pregnancies with laboratory evidence of Zika virus infection during a 9-month period in 2016. This proportion (58.8 per 1,000) is approximately 20 times higher than the

TABLE. Reports of birth defects potentially related to congenital Zika virus infection* collected during a pre-Zika period, by selected characteristics — Massachusetts, North Carolina, and Atlanta, Georgia, 2013–2014†

Characteristic	Brain abnormalities or microcephaly (%)	NTDs and other early brain malformations (%)	Eye abnormalities (%)	Other consequences of CNS dysfunction (%)	Total
No. of infants or fetuses (N = 747)	392 (100)	229 (100)	81 (100)	45 (100)	**747**
Pregnancy outcome					
Live birth	349 (89)	119 (52)	81 (100)	43 (96)	**592**
Pregnancy loss§	43 (11)	109 (48)	0 (—)	2 (4)	**154**
Gestational age at delivery (wks)					
<32	68 (17)	114 (50)	6 (8)	7 (16)	**195**
32–36	80 (20)	37 (16)	18 (22)	9 (20)	**144**
37–41	243 (62)	76 (33)	56 (69)	29 (64)	**404**
≥42	1 (<1)	2 (1)	1 (1)	0 (—)	**4**
Maternal age at delivery (yrs)					
<25	127 (32)	49 (22)	15 (18)	15 (33)	**206**
25–34	178 (45)	122 (54)	42 (52)	21 (47)	**363**
≥35	87 (22)	56 (25)	24 (30)	9 (20)	**176**
Earliest age birth defect was noted (n = 410)¶					
Prenatally	116 (55)	104 (89)	4 (7)	5 (18)	**229**
≤28 days of delivery	58 (27)	9 (8)	29 (54)	19 (70)	**115**
29 days to <3 months	13 (6)	3 (3)	10 (18)	1 (4)	**27**
3 months to <6 months	10 (5)	1 (1)	3 (6)	2 (7)	**16**
≥6 months	15 (7)	0 (—)	8 (15)	0 (—)	**23**
Fetuses/Infants with defects per 1,000 live births (95% CI)	1.50 (1.35–1.65)	0.88 (0.77–1.00)	0.31 (0.25–0.38)	0.17 (0.13–0.23)	**2.86 (2.65–3.07)**

Abbreviations: CNS = central nervous system; CI = confidence interval; NTD = neural tube defect.

* Case reports were aggregated into four mutually exclusive defect categories: 1) brain abnormalities or microcephaly (defined as head circumference at delivery <3rd percentile for sex and gestational age); 2) NTDs and other early brain malformations (these are included as biologically plausible but have been reported much less frequently with Zika virus infection than those in category 1); 3) eye abnormalities (without mention of a brain abnormality in categories 1 or 2); and 4) other consequences of CNS dysfunction, specifically joint contractures and congenital sensorineural deafness, without mention of brain or eye abnormalities included in any other category.

† Data from Massachusetts (2013), North Carolina (2013), and three counties in metropolitan Atlanta, Georgia, (2013–2014). Total live birth population for the three areas = 261,629.

§ Includes stillbirths ≥20 weeks gestation, elective terminations after prenatal diagnosis at any gestational age and, in Massachusetts, spontaneous pregnancy losses at <20 weeks and <350 g.

¶ The earliest age when a birth defect meeting the 2016 CDC Zika surveillance case definition was first noted in the medical record was only available for 410 cases from Massachusetts and metropolitan Atlanta, Georgia.

Summary

What is already known about this topic?

Zika virus infection causes serious brain abnormalities; however, the birth defects observed are not unique to congenital Zika virus infection, and the full range of effects of congenital Zika infection is not known.

What is added by this report?

CDC used data from population-based birth defects surveillance programs in Massachusetts, North Carolina, and Atlanta, Georgia, to retrospectively assess the prevalence of birth defects during 2013–2014 that met the surveillance case definition for birth defects potentially related to Zika virus infection, before introduction of Zika virus into the United States. After introduction of Zika virus, the proportion of infants and fetuses with birth defects born to mothers with laboratory evidence of possible Zika infection reported by the US Zika Pregnancy Registry during January 15–September 22, 2016, was approximately 20 times higher than the prevalence of potentially Zika-related birth defects among pregnancies during the pre-Zika years.

What are the implications for public health practice?

Data on birth defects in the pre-Zika years serve as benchmarks to direct rapid ascertainment and reporting of birth defects potentially related to Zika virus infection. The higher proportion of these defects among pregnancies with laboratory evidence of possible Zika virus infection supports the relationship between congenital Zika virus infection and birth defects.

prevalence (2.86 per 1,000) from the three population-based birth defects surveillance programs during the pre-Zika years. In addition, of the 26 USZPR infants and fetuses, 22 had a brain abnormality or microcephaly (*2*). This proportion (49.8 per 1,000; CI = 33.1–74.8) is approximately 33 times higher than the prevalence (1.5 per 1,000) among pregnancies in the pre-Zika years.

A recently published report from New York took a somewhat different approach to establishing a pre-Zika baseline for congenital birth defects. It examined diagnoses of microcephaly, but not other defects, for the period 2013–2015 and found that, before evidence of importation of Zika virus infections, the overall prevalence of microcephaly in New York was 7.4 per 10,000 live births (0.74 per 1,000), and the prevalence of severe congenital microcephaly (newborn head circumference <3rd percentile for sex and gestational age) was 4.2 per 10,000 (0.42 per 1,000) (*8*).

The findings in this report are subject to at least six limitations. First, population-based surveillance programs strive to ascertain the prevalence of birth defects among all members of a specified population. In contrast, the aim of USZPR is to estimate the proportion of birth defects among pregnancies with laboratory evidence of possible Zika virus infection, a specific subgroup of the general population (*2*). This could lead to selection bias with USZPR if, for example, pregnancies with fetal abnormalities detected prenatally were more likely to be tested for Zika virus and reported. Second, birth defects surveillance programs identify diagnoses among infants and fetuses mostly through review of administrative records, often at inpatient facilities. Although these programs use multisource ascertainment, some birth defects could be missed if they were prenatally diagnosed or if infants were delivered at sites outside of the usual ascertainment sources, if infants were evaluated solely in outpatient settings, or if some birth defect diagnoses did not receive an administrative code. In contrast, USZPR receives reports of pregnant women with laboratory evidence of possible Zika virus infection and resulting fetal and infant outcomes. The prospective nature of this ascertainment and direct follow-up of individual reported pregnancies could result in closer scrutiny of the outcomes and more frequent and detailed detection of abnormalities than is typical with population-based birth defects surveillance programs. Third, data from these three birth defects surveillance programs might not be generalizable to the United States. The USZPR-published data included reports from any of the U.S states and the District of Columbia. Also, it is possible that some pregnancies with Zika virus infection were present in the birth defects surveillance populations during the pre-Zika years as a result of travel to areas with Zika virus outside the Americas. Fourth, birth defects surveillance programs traditionally do not ascertain diagnoses from settings where congenital deafness is diagnosed; therefore, these data likely do not include the majority of infants with congenital sensorineural deafness. Fifth, published data from USZPR on the proportion of infants and fetuses with other types of birth defects that are not thought to result from congenital Zika virus infection are not available, making it impossible to assess differences in the frequency of other birth defects. Finally, published data from USZPR include many pregnancies with unspecified flavivirus infections, and thus the estimates of the proportion with birth defects potentially related to Zika virus infection might underestimate the actual Zika impact, given that some included pregnant women likely had other flavivirus infections, increasing the size of the denominator.

The birth defects surveillance data in this report were compiled from a period before introduction of Zika virus in the Americas, using the CDC surveillance case definition of birth defects potentially related to Zika virus infection; this is the same case definition adopted by USZPR. The higher proportion of these defects among pregnancies with laboratory evidence of Zika infection in USZPR supports the relationship between congenital Zika virus infection and these birth defects (*1*,*2*). These data demonstrate the critical contribution of population-based birth defects surveillance to understanding the impact of Zika virus infection during pregnancy. In 2016, CDC provided funding for 45 local, state, and territorial health departments to conduct rapid population-based surveillance for defects potentially related to Zika virus infection, which will provide essential data to monitor the impact of Zika virus infection in the United States.

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Reported Adverse Health Effects in Children from Ingestion of Alcohol-Based Hand Sanitizers — United States, 2011–2014

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Hand sanitizers are effective and inexpensive products that can reduce microorganisms on the skin, but ingestion or improper use can be associated with health risks. Many hand sanitizers contain up to 60%–95% ethanol or isopropyl alcohol by volume, and are often combined with scents that might be appealing to young children. Recent reports have identified serious consequences, including apnea, acidosis, and coma in young children who swallowed alcohol-based (alcohol) hand sanitizer (*1*–*3*). Poison control centers collect data on intentional and unintentional exposures to hand sanitizer solutions resulting from various routes of exposure, including ingestion, inhalation, and dermal and ocular exposures. To characterize exposures of children aged ≤12 years to alcohol hand sanitizers, CDC analyzed data reported to the National Poison Data System (NPDS).* The major route of exposure to both alcohol and nonalcohol-based (nonalcohol) hand sanitizers was ingestion. The majority of intentional exposures to alcohol hand sanitizers occurred in children aged 6–12 years. Alcohol hand sanitizer exposures were associated with worse outcomes than were nonalcohol hand sanitizer exposures. Caregivers and health care providers should be aware of the potential dangers associated with hand sanitizer ingestion. Children using alcohol hand sanitizers should be supervised and these products should be kept out of reach from children when not in use.

In 2005, the annual rate of intentional alcohol hand sanitizer exposure was 0.68 per 1 million U.S. residents (95% confidence interval [CI] = 0.17–1.20) (*4*). During 2005–2009, this rate increased, on average, by 0.32 per 1 million per year (95% CI = 0.11–0.53; p = 0.02) (*4*). Young children, including infants, are more likely to develop complications from alcohol intoxication than are older children and teens. Younger children have decreased liver glycogen stores, which increase their risk of developing hypoglycemia, and have various pharmokinetic factors, which make them more susceptible to developing toxicity from alcohol (*5*–*9*). To characterize pediatric alcohol hand sanitizer exposures in the United States, data reported by poison centers in all states to NPDS among children aged ≤12 years during January 1, 2011–December 31, 2014 were analyzed. Analyses were stratified by age group (0–5 years and 6–12 years). Hand sanitizer exposures were defined as a poison center call reporting an exposure to either ethanol-based or isopropanol-based sanitizer solutions (alcohol hand sanitizer exposure) or a nonalcohol sanitizer product (nonalcohol hand sanitizer exposure). Calls reporting co-exposures to other agents were excluded to minimize confounding effects.

Descriptive statistics were compiled for exposed children's age, year and season of exposure, intentionality of exposure, route of exposure (ingestion, inhalation, dermal, or ocular), reported health effects (e.g., drowsiness, eye irritation, nausea, vomiting, etc.), and outcome,† and were compared for alcohol and nonalcohol hand sanitizers and age group. An exposure was coded by poison centers as unintentional if it was considered to be accidental or inadvertent. Deliberate exposures, because of deliberate misuse or abuse for example, were considered intentional. An exposure was considered to have resulted in an adverse health effect if at least one symptom (e.g., abdominal pain, nausea, vomiting, etc.) was reported. Categorical data comparisons were performed using the chi-square test or, when cell sizes were <5, Fisher's exact test. Significance was defined as p<0.05. Statistical software was used for the analysis.

During 2011–2014, a total of 70,669 hand sanitizer exposures in children aged ≤12 years were reported to NPDS, including 65,293 (92%) alcohol exposures, and 5,376 (8%) nonalcohol exposures (Table 1). The number and percentage of each type of reported exposure was similar during each of the 4 years. Overall, 64,488 (91%) exposures occurred in children aged ≤5 years, and 6,181 (9%) occurred in children aged 6–12 years. There was no association between sanitizer type and year. Among all children, ingestion accounted for approximately 95% of reported exposures, including 97% of exposures among children aged ≤5 years (97.0% alcohol and 96.3% nonalcohol exposures) and 74% among children aged 6–12 years (74.0% alcohol and 72.0% nonalcohol exposures). A higher percentage of older children (aged 6–12 years) had intentional exposures to alcohol hand sanitizers (866; 15.0%) than to nonalcohol hand sanitizers (40; 8.0%) (p<0.001). This

* https://www.npds.us.

† Minor outcomes were defined as the occurrence of some symptoms as a result of the exposure, which were minimally bothersome to the patient, usually resolved rapidly, and often involved skin or mucous membrane manifestations, and after which, the patient returned to a preexposure state of well-being with no residual disability or disfigurement. Moderate outcomes were defined as the occurrence of symptoms as a result of the exposure that were more pronounced, more prolonged, or of a more systemic nature than minor symptoms; for which some form of treatment usually was or would have been indicated; were not life-threatening; and after which, the patient returned to a preexposure state of well-being with no residual disability or disfigurement. Major outcomes were defined as the occurrence of symptoms as a result of the exposure that were life-threatening or resulted in significant residual disability or disfigurement.

TABLE 1. Exposures to alcohol and nonalcohol hand sanitizer products among children aged ≤12 years reported to poison centers, by sanitizer type, year, age group, exposure route, and intentionality — United States, National Poison Data System, 2011–2014

	No. (%) of exposures		
Year	**Alcohol**	**Nonalcohol**	**Total**
Total	**65,293 (92.4)**	**5,376 (7.6)**	**70,669**
2011	15,971 (92.5)	1,286 (7.5)	**17,257**
2012	16,571 (92.4)	1,355 (7.6)	**17,926**
2013	16,423 (92.5)	1,338 (7.5)	**17,761**
2014	16,328 (92.1)	1,397 (7.9)	**17,725**
Age group 0–5 yrs			
Total	**59,612 (92.4)**	**4,876 (7.6)**	**64,488 (91.2)***
Exposure route			
Ingestion	57,825 (97.0)	4,698 (96.3)	**62,523 (97.0)**
Inhalation	74 (0.1)	10 (0.2)	**84 (0.1)**
Dermal	2,385 (4.0)	135 (2.8)	**2,520 (3.9)**
Ocular	1,782 (3.0)	157 (3.2)	**1,939 (3.0)**
Intentionality			
Intentional	37 (0.1)	1 (0.0)	**38 (0.1)**
Unintentional	59,575 (99.9)	4,875 (100.0)	**64,450 (99.9)**
Age group 6–12 yrs			
Total	**5,681 (91.9)**	**500 (8.1)**	**6,181 (8.7)***
Exposure route			
Ingestion	4,204 (74.0)	351 (70.2)	**4,555 (74.0)**
Inhalation	81 (1.4)	6 (1.2)	**87 (1.4)**
Dermal	180 (3.2)	9 (1.8)	**189 (3.1)**
Ocular	1,387 (24.4)	145 (29.0)	**1,532 (24.8)**
Intentionality			
Intentional	866 (15.2)	40 (8.0)	**906 (14.7)**
Unintentional	4,815 (84.8)	460 (92.0)	**5,275 (85.3)**

* Percentage of total exposures.

association was not found in younger children (aged ≤5 years). Ocular exposures to hand sanitizers were more common in older children (24.8% overall, 24.4% alcohol, and 29.0% nonalcohol) than among younger children (3.0% overall, 3.0% alcohol, and 3.2% nonalcohol). Although there was no seasonal variation in reported exposure to either hand sanitizer type among younger children, exposure frequency among older children was lower for both hand sanitizer types during the summer months (Figure).

Overall, 8,219 (12%) patients had at least one reported symptom, including 7,703 (12%) children who ingested alcohol products, and 516 (10%) who ingested nonalcohol products. Adverse health effects were more likely to be reported for alcohol hand sanitizer exposures (p<0.001). The most common adverse health effects for both hand sanitizer types were ocular irritation (2,577; 31.4%) and vomiting (1,872; 22.8%). Conjunctivitis (862; 10.5%), oral irritation (782; 9.5%), cough (705; 8.6%), and abdominal pain (323; 3.9%) were also reported (Table 2). Rare health effects included coma (five), seizures (three), hypoglycemia (two), metabolic acidosis (two), and respiratory depression (two). Those rare effects occurred more frequently among children with alcohol hand sanitizer exposures, but the differences were not statistically significant when the rare health effects were analyzed individually. Alcohol hand sanitizers were significantly associated with worse outcomes (compared with no effect outcomes) when both age groups were analyzed (p = 0.02). Approximately two thirds (66%) of children with exposures were not followed to determine outcome (Table 2). Among patients who were followed (23,828), exposure to alcohol hand sanitizers had no reported effect in 17,441 (85%) of the younger children. In contrast, 1,005 (50%) of the older children had no reported effect to alcohol hand sanitizer exposure. No deaths were reported.

Discussion

In this analysis, alcohol hand sanitizer exposures, the majority of which were ingestions, were associated with worse outcomes than nonalcohol hand sanitizer exposures. Older children (aged 6–12 years) were more likely to report intentional ingestion and to have adverse health effects and worse outcomes than were younger children, suggesting that older children might be deliberately misusing or abusing alcohol hand sanitizers. These data also indicate that, among older children, exposures occur less frequently during the summer months. The reason for this seasonal trend is unknown but might be associated with flu season or more ready access to hand sanitizers during the school year. Some schools might require or ask children to purchase and carry hand sanitizers, which might contribute to the higher number of exposures during the school year. A study examining Texas poison center data from 2000 to 2013 found that, among 385 adolescents who ingested hand sanitizer, 35% of ingestions occurred at school (*10*).

The findings in this report are subject to at least three limitations, which might have led to an underestimate of the total number of alcohol and nonalcohol hand sanitizer exposures. First, calls involving hand sanitizer exposures and another exposure were excluded. Second, the codes indicating an alcohol hand sanitizer exposure also were changed in 2010 and might have been initially underused. Finally, public and health care providers, including emergency department providers, also might not have reported all alcohol or nonalcohol hand sanitizer exposures to poison centers. Moreover, poison center data are also subject to inherent biases such as selection bias (e.g., if poisoning is unrecognized as a cause) or information bias (e.g., recall or interviewer bias). An important example of information bias in this study could be exposure intentionality being incorrectly coded because of inaccurate or subjective history obtained by the caller.

Hand washing with soap and water is the recommended method of hand hygiene in non–health care settings. If soap and water are not available, use of a hand sanitizer that contains

FIGURE. Percentage of exposures from alcohol-based and nonalcohol-based hand sanitizer products in children aged ≤5 years and 6–12 years reported to poison centers, by month — United States, National Poison Data System, January 1, 2011–December 31, 2014

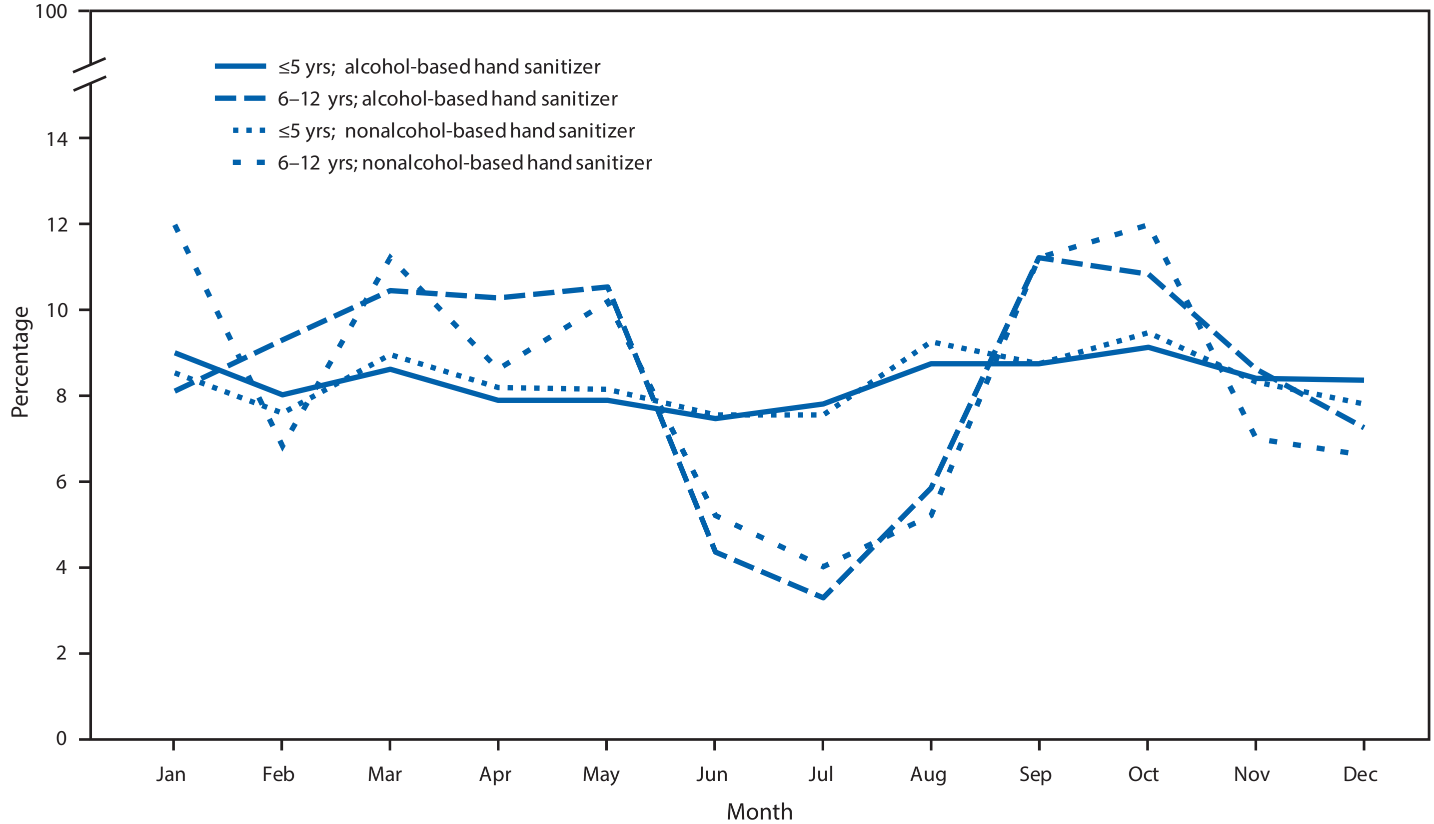

TABLE 2. Most common adverse health effects and outcomes experienced by children with exposure to alcohol and nonalcohol hand sanitizers, by age group — United States, 2011–2014

	No. (%)				
	Alcohol	Nonalcohol	Alcohol	Nonalcohol	
Characteristic	**<5 yrs**	**<5 yrs**	**6–12 yrs**	**6–12 yrs**	**Total**
Total	**59,612**	**4,876**	**5,681**	**500**	**70,669**
Symptoms					
Reported symptoms	5,867 (9.8)	379 (7.8)	1,836 (32.3)	137 (27.4)	**8,219 (11.6)**
Ocular irritation	1,306 (22.3)*	97 (25.6)*	1,080 (58.8)*	94 (68.6)*	**2,577 (31.4)**
Vomiting	1,606 (27.4)*	129 (34.0)*	129 (7.0)	8 (5.8)*	**1,872 (22.8)**
Red eye/Conjunctivitis	492 (8.4)	33 (8.7)	316 (17.2)*	21 (15.3)*	**862 (10.5)**
Oral irritation	699 (11.9)*	26 (6.9)	55 (3.0)	2 (1.5)	**782 (9.5)**
Cough	651 (11.1)	43 (11.4)*	11 (0.6)	0 (0.0)	**705 (8.6)**
Abdominal pain	173 (3.0)	10 (2.6)	135 (7.4)*	5 (3.7)	**323 (3.9)**
Outcomes					
No effect	17,441 (29.3)	956 (19.6)	1,005 (17.7)	71 (14.2)	**19,473 (27.6)**
Minor outcome†	2,957 (5.0)	188 (3.9)	962 (16.9)	85 (17.0)	**4,192 (5.9)**
Moderate outcome§	105 (0.2)	4 (0.1)	45 (0.8)	4 (0.8)	**158 (0.2)**
Major outcome¶	4 (0.0)	0 (0.0)	1 (0.0)	0 (0.0)	**5 (0.0)**
Not followed	39,105 (65.6)	3,728 (76.5)	3,668 (64.6)	340 (68.0)	**46,841 (66.3)**

* The three most commonly reported symptoms per column.
† The patient exhibited some symptoms as a result of the exposure, but they were minimally bothersome to the patient. The symptoms usually resolved rapidly and often involved skin or mucous membrane manifestations. The patient returned to a preexposure state of well-being and had no residual disability or disfigurement.
§ The patient exhibited symptoms as a result of the exposure that were more pronounced, more prolonged, or more of a systemic nature than minor symptoms. Usually some form of treatment was or would have been indicated. Symptoms were not life-threatening and the patient returned to a preexposure state of well-being with no residual disability or disfigurement.
¶ The patient exhibited symptoms as a result of the exposure that were life-threatening or resulted in significant residual disability or disfigurement.

at least 60% alcohol is suggested.[§] Other options, such as nonalcohol hand sanitizers or wipes, can be used if soap and water or alcohol hand sanitizers are not available or practical. In September 2016, the Food and Drug Administration issued a rule banning the use of triclosan, triclocarban, and 17 other chemicals in consumer hand and body antibacterial soaps and washes because of health and bacterial resistance concerns. However, this ban does not apply to hand sanitizers, hand wipes, or antibacterial soaps used in a health care setting.[¶] Hand washing with plain soap and water is safe and effective and does not carry these associated risks.

Increasing awareness of the potential dangers associated with intentional or unintentional ingestion of alcohol hand sanitizers might help encourage proper use and avoid adverse outcomes. Using alcohol hand sanitizers correctly, under adult supervision, and with proper child safety precautions and making sure they are stored out of reach of young children might reduce unintended adverse consequences. Clinicians evaluating pediatric patients with clinical signs and symptoms consistent with alcohol toxicity, such as nausea, vomiting, respiratory depression, and drowsiness or laboratory results consistent with ethanol or isopropanol toxicity, should consider the possibility of an alcohol hand sanitizer ingestion and contact their local poison control center.

[§] https://www.cdc.gov/handwashing/show-me-the-science-hand-sanitizer.html.
[¶] https://www.fda.gov/ForConsumers/ConsumerUpdates/ucm378393.htm.

Summary

What is already known about this topic?

Nonrecommended use of alcohol-based (alcohol) hand sanitizers, including intentional or unintentional ingestion, might be associated with greater health risks in young children than similar use of nonalcohol-based (nonalcohol) hand sanitizers.

What is added by this report?

During 2011–2014, 70,669 exposures to alcohol and nonalcohol hand sanitizers were reported in children aged ≤12 years to the National Poison Data System. Approximately 90% of these exposures occurred among children aged 0–5 years. Among that age group, 97% of exposures were oral ingestions. Children aged 6–12 years had more intentional exposures of alcohol hand sanitizers, suggesting this might be a potential product of abuse among older children. Older children also reported more symptoms and had worse outcomes than did younger children. Major (life-threatening) outcomes were rare. Seasonal trends in data might correlate with increased use during the school year or flu season.

What are the implications for public health practice?

Caregivers and health care providers need to be aware of the potential risks and dangers associated with improper use of hand sanitizer products among children and the need to use proper safety precautions to protect children. Increased parental or teacher supervision might be needed while using alcohol hand sanitizer products, especially for older children who might be abusing these products during the school year.

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Response to a Large Polio Outbreak in a Setting of Conflict — Middle East, 2013–2015

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As the world advances toward the eradication of polio, outbreaks of wild poliovirus (WPV) in polio-free regions pose a substantial risk to the timeline for global eradication. Countries and regions experiencing active conflict, chronic insecurity, and large-scale displacement of persons are particularly vulnerable to outbreaks because of the disruption of health care and immunization services (*1*). A polio outbreak occurred in the Middle East, beginning in Syria in 2013 with subsequent spread to Iraq (*2*). The outbreak occurred 2 years after the onset of the Syrian civil war, resulted in 38 cases, and was the first time WPV was detected in Syria in approximately a decade (*3*,*4*). The national governments of eight countries designated the outbreak a public health emergency and collaborated with partners in the Global Polio Eradication Initiative (GPEI) to develop a multiphase outbreak response plan focused on improving the quality of acute flaccid paralysis (AFP) surveillance* and administering polio vaccines to >27 million children during multiple rounds of supplementary immunization activities (SIAs).† Successful implementation of the response plan led to containment and interruption of the outbreak within 6 months of its identification. The concerted approach adopted in response to this outbreak could serve as a model for responding to polio outbreaks in settings of conflict and political instability.

Outbreak Detection and Epidemiology

Detection of the Middle East outbreak depended upon systems for AFP surveillance in the affected countries, including the World Health Organization's (WHO's) Early Warning, Alert and Response Network (EWARN)§, through which the outbreak was identified in October 2013. The nonpolio AFP (NPAFP) and stool adequacy rates served as indicators for assessing the ability of the affected countries to detect polio cases and also to determine when the outbreak had been interrupted.

Among countries that reported polio cases, the NPAFP rate in Syria in 2012 was 1.4 cases per 100,000 persons aged <15 years, below the recommended benchmark of ≥2. The NPAFP rate for Syria improved, increasing to 1.7 cases per 100,000 persons in 2013, the year the outbreak was detected, and to 4.0 and 3.0 in 2014 and 2015, respectively (Table). In Iraq, the NPAFP rate ranged from 3.1 to 4.0 during 2012–2015; estimates of NPAFP rates in Syria and Iraq might, however, be inaccurate because of the large-scale conflict-related displacement of persons and the attendant impact on target population estimates. Among countries at risk, NPAFP rates were suboptimal in Jordan at the onset, but improved over the course of the outbreak, increasing from 1.4 in 2013 to 3.2 in 2015. Despite incremental improvements, NPAFP rates remained <2 in Turkey over the course of the outbreak, and rates declined in Palestine from 2.2 in 2013 to 1.2 in 2014 before improving to 2.2 in 2015. All other countries involved in the response achieved recommended benchmarks.

Rates of stool specimen adequacy (i.e., receipt of two stool specimens collected at least 24 hours apart within 14 days of paralysis onset and properly shipped to the laboratory) in Syria increased from 68% in 2013 to 90% in 2015; in Iraq, rates of stool specimen adequacy exceeded the benchmark of ≥80% in each year during 2012–2015. Lebanon showed substantial gaps in stool specimen adequacy before and during the outbreak with rates ranging from 45% to 70% during 2012–2014, but the rate improved to 84% in 2015.

A total of 38 WPV type 1 cases were reported during the outbreak, with dates of paralysis onset ranging from July 14, 2013 for the index case (Aleppo, Syria) to April 7, 2014 for the last confirmed case (Baghdad, Iraq). The outbreak was virologically confirmed in October 2013. Of the 38 cases reported, 36 occurred in Syria and two occurred in Iraq (Figure 1). Approximately two thirds (24 of 38) of reported cases occurred in male children and 74% of cases occurred in children aged <2 years. Fifty-eight percent of children with polio had never received oral poliovirus vaccine (OPV) either through routine or supplementary immunization (i.e., zero-dose children), and an additional 37% of children with polio

* The quality of acute flaccid paralysis (AFP) surveillance is monitored by performance indicators that include 1) the detection rate of nonpolio AFP (NPAFP) cases, and 2) the proportion of AFP cases with adequate stool specimens. World Health Organization (WHO) operational targets for countries with endemic poliovirus transmission are an NPAFP detection rate of ≥2 cases per 100,000 population aged <15 years, and adequate stool specimen collection from ≥80% of AFP cases, in which two specimens are collected ≥24 hours apart, both within 14 days of paralysis onset, and shipped on ice or frozen packs to a WHO-accredited laboratory, arriving in good condition (without leakage or desiccation).

† Mass campaigns conducted for a brief period (days to weeks) in which 1 dose of oral poliovirus vaccine is administered to all children aged <5 years, regardless of vaccination history. Campaigns are conducted nationally or subnationally (i.e., in portions of the country).

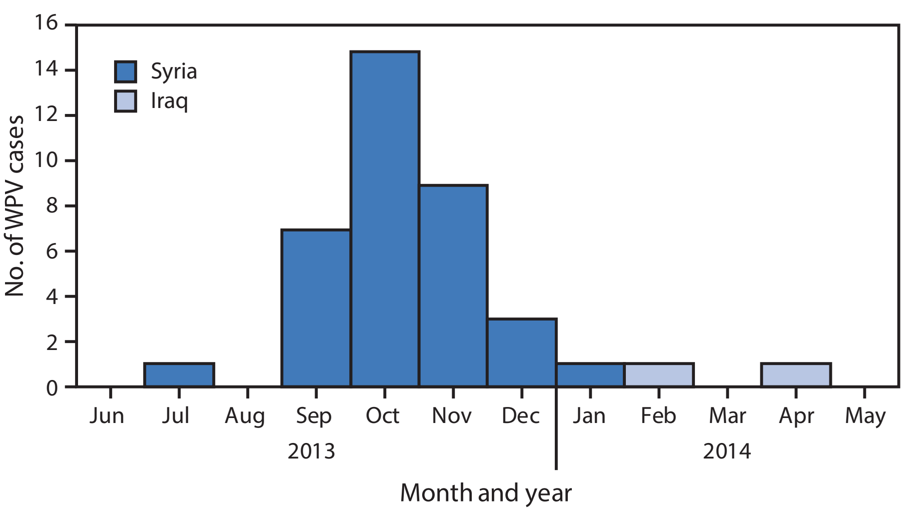
§ http://apps.who.int/iris/bitstream/10665/70812/1/WHO_HSE_GAR_DCE_2012_1_eng.pdf.

TABLE. Acute flaccid paralysis (AFP) surveillance indicators and outbreak response activities by country and year — eight countries in the Middle East, 2012–2015

	Country							
Year/Activity	**Egypt**	**Iran**	**Iraq**	**Jordan**	**Lebanon**	**Palestine**	**Syria**	**Turkey**
2012								
Nonpolio AFP rate*	3.9	3.5	3.8	1.5	2.2	1.3	1.4	0.9
AFP cases with adequate specimens (%)	92	92	90	84	50	95	84	80
2013								
Nonpolio AFP rate*	3	4	3.1	1.4	2.2	2.2	1.7	1.2
AFP cases with adequate specimens (%)	92	96	84	91	45	95	68	76
SIAs	2 NIDs	—†	2 NIDs; 1 SNID	2 NIDs	2 NIDs	1 NID	2 NIDs	2 SNIDs
2014								
Nonpolio AFP rate*	2.9	4.2	4	2.5	2.7	1.2	4	1.5
AFP cases with adequate specimens (%)	93	96	89	97	70	90	84	77
SIAs	2 NIDs; 1 SNID	2 SNIDs	7 NIDs; 3 SNIDs	3 NIDs; 2 SNIDs	4 NIDs; 3 SNIDs	1 NID	8 NIDs; 1 SNID	5 SNIDs
2015								
Nonpolio AFP rate*	3	4.3	3.6	3.2	5.2	2.2	3	1.7
AFP cases with adequate specimens (%)	94	97	82	97	84	92	90	82
SIAs	1 NID; 2 SNIDs	2 SNIDs	5 NIDs	1 SNID	2 SNIDs	—†	4 NIDs; 2 SNIDs	2 SNIDs

Abbreviations: NIDs = national immunization days; SIAs = supplemental immunization activities; SNIDs = subnational immunization days.
* Cases per 100,000 children aged <15 years (target: ≥2 per 100,000).
† No NIDs or SNIDs conducted for the year.

FIGURE 1. Number of cases of wild poliovirus type 1 (WPV1), by month and year of paralysis onset — Syria and Iraq, 2013–2014



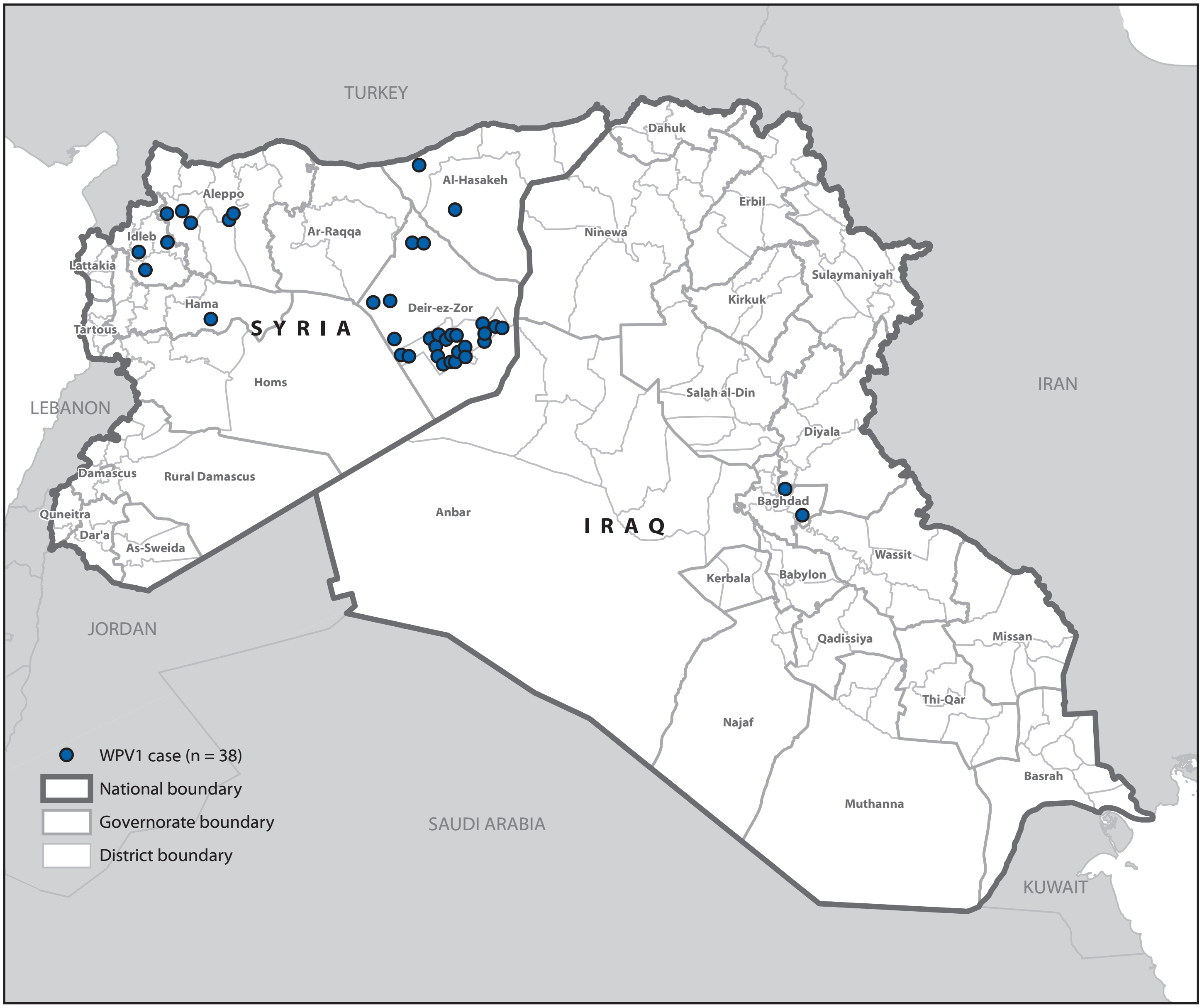
had received ≤3 OPV doses. The remaining 5% of children with polio had received 3 OPV doses.

Thirty-five of the 36 polio cases in Syria were reported during 2013 and the last identified case had paralysis onset in January 2014. A breakdown of cases by governorate (Figure 2) indicates that 25 (69%) cases were reported from Deirez-Zour, five from Aleppo, three from Edleb, two from Hasakeh, and one from Hama. The two cases reported from Iraq occurred in February and April 2014; both were from Baghdad-Resafa Governorate. Both cases were related by genetic sequencing and were closely linked to WPV circulating in Syria. Genetic sequencing indicated virus circulation might have begun a year earlier somewhere in the Middle East, coincident with identification of WPV-positive environmental samples in Egypt in December 2012 (*5*). The implicated viral strain was genetically linked to strains circulating in Pakistan (*6*).

Outbreak Response Plan Development

Eight countries in the region (Egypt, Iran, Iraq, Jordan, Lebanon, Palestine, Syria, and Turkey) developed a concerted Middle East polio outbreak response plan, which was updated during the course of the outbreak. Countries were grouped into two areas: 1) countries with poliovirus transmission (Syria and Iraq), and 2) countries at significant risk for poliovirus importation based on geographic proximity and influx of displaced persons from the outbreak zone (Egypt, Iran, Jordan, Lebanon, Palestine, and Turkey). The strategic response in these areas occurred in three phases. Phase I (October 2013–April 2014) focused on interrupting WPV transmission and halting spread of the virus beyond the affected countries. Phase II (May 2014–January 2015) identified areas at high risk for poliovirus importation and circulation based on stipulated criteria, including presence of refugees and mobile populations, security-compromised areas, districts with low vaccination coverage, and geographically hard-to-reach communities. These areas were prioritized for SIAs and intensified surveillance

FIGURE 2. Cases of wild poliovirus type 1 (WPV1) — Syria and Iraq, 2013–2014*



* Each dot represents one case. Dots are randomly placed within second administrative units.

activities. Phase III (February–October 2015) was aimed at further boosting population immunity against polio through strengthened routine immunization systems and SIAs.

Immunization Coverage. Conflict in Syria and Iraq in the years preceding and following the outbreak led to steep declines in routine vaccination coverage among children in both countries, in contrast to most other countries in the Middle East where coverage remained high. Estimated national routine vaccination coverage of infants in Syria with 3 doses of oral poliovirus vaccine (OPV3) declined from preconflict levels of 83% in 2010 to 47%–52% during 2012–2014.¶ Estimates of coverage in Iraq were ≤70% and coverage in Lebanon was 75% during 2012–2014. All other countries involved in the response had coverage levels of >90% during 2012–2014.

In response to the Middle East polio outbreak, >70 SIAs were conducted during October 2013–December 2015. SIAs targeted approximately 27 million children aged <5 years in eight countries and were conducted using trivalent (types 1, 2, and 3) and bivalent (types 1 and 3) OPV. Strategies used during

¶ http://apps.who.int/immunization_monitoring/globalsummary.

the campaigns included fixed-post (health facility), house-to-house visits, transit-point vaccination, and deployment of mobile teams to vulnerable populations and geographically hard-to-reach areas. Strategies were tailored to the unique sociocultural context of each country involved in the response.

Implementation of outbreak response plan. Following identification of the outbreak, Syria conducted two rounds of national immunization days (NIDs) in November and December 2013, eight NIDs and one round of subnational immunization days (SNIDs) in 2014, and four NIDs and two SNIDs in 2015 (Table). Postcampaign monitoring coverage estimates improved from 79% in December 2013 to 93% in March 2014, with coverage levels ≥88% during a majority of the campaigns. Iraq held 14 NIDs and four SNIDs as part of the response, with postcampaign monitoring coverage levels ranging from 86% to 94% during 2014. Egypt, Iran, Jordan, Lebanon, Palestine, and Turkey conducted two to 11 vaccination campaigns.

Active conflict in many parts of Syria and some parts of Iraq limited access for vaccination activities during the course of the response. Negotiations with local authorities and engagement of community leaders enabled implementation of a limited number of vaccination campaigns in some conflict-affected areas, but it was difficult to monitor these campaigns, or generate reliable data on the quality of response activities. Egypt, Iraq, Jordan, Lebanon, and Turkey received large numbers of Syrian refugees (*7*), which placed significant strain on their health care resources and increased costs of implementing outbreak response activities. Refugees aged <15 years living in camps in Jordan were vaccinated against polio upon registration and entry, and during special vaccination campaigns held in camps.

In assessing the effect of outbreak response activities, the vaccination status of nonpolio AFP cases in children aged 6–59 months in Syria and Iraq was reviewed. The proportion of NPAFP cases among children aged 6–59 months who were reported to have received ≥3 doses of OPV in Syria rose from 82% in 2013 to 94% in 2015, but remained at 93% among Iraqi children of the same age group during 2013–2015. The proportion of children aged 6–59 months with NPAFP who had never received OPV, or any other form of polio vaccination, decreased from 9% in 2013 to 2% in 2015 in Syria, but increased slightly from 1% to 3% in Iraq during the same period.

Discussion

The Middle East polio outbreak occurred within an extremely challenging setting, given the ongoing civil war in Syria and conflict in several parts of Iraq. The near collapse of the health care system in conflict-affected parts of Syria resulted in plummeting levels of routine vaccination coverage that left many children born after the start of the civil war unimmunized or underimmunized against polio, and set the stage for the spread of poliovirus following importation within this age group and beyond.

Actions were taken to mitigate the risk for a polio outbreak in Syria when WPV-positive environmental isolates were identified in Egypt late in 2012. AFP surveillance activities in Syria, including in opposition-controlled areas, were intensified through WHO's EWARN system, and polio vaccination campaigns were conducted in all of Syria's governorates by January 2013 (*6*). However, the cohort of children born during the conflict remained vulnerable to a polio outbreak because of steep declines in routine polio vaccination coverage.

After a cluster of WPV cases was detected in Deirez-Zour Governorate, the government of Syria immediately declared the outbreak a public health emergency. A multicountry response plan was developed to contain and interrupt the outbreak, which was effectively contained within 6 months from the time of its identification. Improvements in AFP surveillance performance indicators in the outbreak-affected countries provided a basis for WHO to declare the outbreak over in 2015. In addition to intensified surveillance and immunization activities,

Summary

What is already known about this topic?

Afghanistan, Nigeria, and Pakistan are the only three countries that have never interrupted endemic transmission of wild poliovirus (WPV). Continued WPV circulation in these countries poses a risk for polio outbreaks in polio-free regions of the world, especially in countries experiencing conflict and insecurity, with attendant disruption of health care and immunization services.

What is added by this report?

A WPV outbreak occurred in Syria and Iraq during 2013–2014 after importation of a poliovirus strain circulating in Pakistan. The outbreak represented the first occurrence of polio cases in both countries in approximately a decade, and resulted in 38 polio cases, including 36 in Syria and two in Iraq. Development and implementation of an integrated response plan for strengthening acute flaccid paralysis surveillance and synchronized mass vaccination campaigns by eight national governments in the Middle East facilitated interruption of the outbreak within 6 months of its identification.

What are the implications for public health practice?

Countries experiencing active conflict and chronic insecurity are at increased risk for polio outbreaks because of political instability and population displacement hindering delivery of immunization services. Adoption of a concerted approach to planning and implementing response activities, with involvement of more stable neighboring countries, could serve as a useful model for polio outbreak response in areas affected by conflict, as exemplified by the Middle East polio outbreak response.

the response owed its success in large part to the level of collaboration and concerted approach adopted by eight national governments in the region. Another factor contributing to the success of the response was that high routine immunization coverage in many countries in the region, coupled with high prewar vaccination coverage in Syria, limited the population of vulnerable persons to mostly children born after the onset of the civil war.

With the attention of GPEI focused on the final push to interrupt indigenous WPV transmission in the remaining three polio-endemic countries (*8*–*10*), vigilance must be maintained in the Middle East and other conflict-affected areas to forestall the risk for new WPV outbreaks. In the event of a new outbreak, the Middle East polio outbreak response provides a model for an effective response within challenging settings.

Acknowledgments

Chris Maher, Polio Eradication Department, World Health Organization; Steven Wassilak, Global Immunization Division, CDC; Office of Public Health Preparedness and Response, CDC; World Health Organization Global Polio Laboratory Network.

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Announcement

National Kidney Month — March 2017

Each year, March is designated National Kidney Month to raise awareness about the prevention and early detection of kidney disease. In the United States, kidney disease is the ninth leading cause of death (*1*). Approximately one in seven (15%) U.S. adults aged ≥20 years are estimated to have chronic kidney disease, most of whom are unaware of their condition (*2*). If left untreated, chronic kidney disease can lead to kidney failure, requiring dialysis or transplantation for survival (*3*).

Risk factors for chronic kidney disease include diabetes, high blood pressure, cardiovascular disease, and obesity (*3*), and controlling diabetes and high blood pressure can delay or prevent chronic kidney disease and improve health outcomes (*3*). Lifestyle changes to increase physical activity, improve nutrition, and lose weight have been shown to prevent or delay type 2 diabetes among persons at risk (*4*), and might offer the greatest benefit in preventing chronic kidney disease.

In collaboration with partners, CDC supports and maintains the Chronic Kidney Disease Surveillance Project website (https://www.cdc.gov/ckd/surveillance) to document and monitor the burden of chronic kidney disease and its risk factors in the U.S. population and to track progress in chronic kidney disease prevention, detection, and management (*2*). Information is available about kidney disease prevention and control at https://www.nkdep.nih.gov and about diabetes prevention and control at https://www.cdc.gov/diabetes.

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Erratum

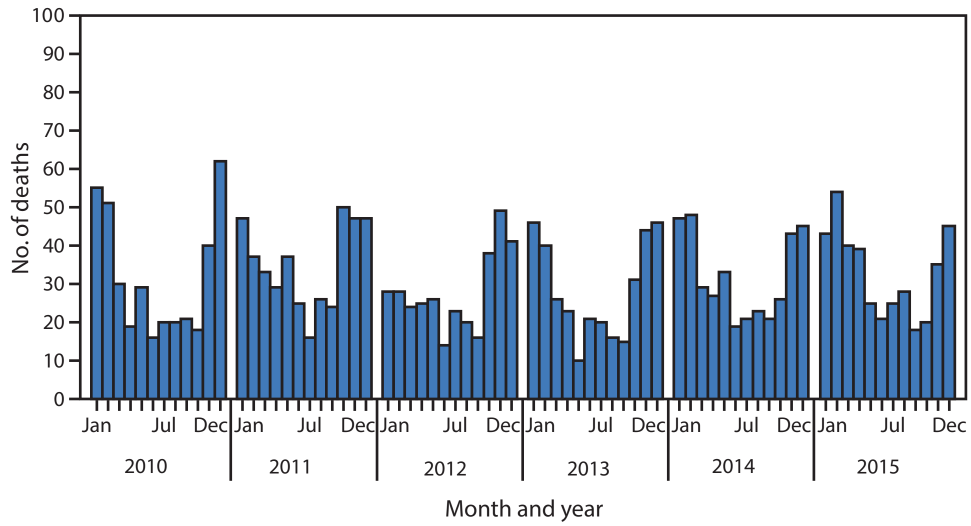
Vol. 66, No. 5

In the report "Advisory Committee on Immunization Practices Recommended Immunization Schedule for Adults Aged 19 Years or Older — United States, 2017," on page 138, the fifth bullet point under the heading "Meningococcal vaccination" should have read "Young adults aged 16 through 23 years (preferred age range is 16 through 18 years) who are healthy and not at increased risk for serogroup B meningococcal disease may receive **either a 2-dose series of MenB-4C at least 1 month apart or a 2-dose series of MenB-FHbp at 0 and 6 months** for short-term protection against most strains of serogroup B meningococcal disease."

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Number of Deaths Resulting from Unintentional Carbon Monoxide Poisoning,* by Month and Year — National Vital Statistics System, United States, 2010–2015



* Unintentional carbon monoxide poisoning is defined by *International Classification of Diseases, Tenth Revision* codes X47 (underlying cause of death) and T58 (toxic effect of carbon monoxide as multiple-cause-of-death).

During 2010–2015, a total of 2,244 deaths resulted from unintentional carbon monoxide poisoning, with the highest numbers of deaths each year occurring in winter months. In 2015, a total of 393 deaths resulting from unintentional carbon monoxide poisoning occurred, with 36% of the deaths occurring in December, January, or February.

Source: National Vital Statistics System. Mortality public use data files, 2016. https://www.cdc.gov/nchs/data_access/vitalstatsonline.htm.

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ISSN: 0149-2195 (Print)