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Workers' Memorial Day — April 28, 2014

Workers' Memorial Day, observed on April 28, 2014, recognizes workers who died or suffered from exposures to hazards at work. In 2012, a total of 4,383 U.S. workers died from work-related injuries (*1*). Most fatalities from work-related illness are not captured by national surveillance systems, but an estimate for 2007 was 53,445 deaths (*2*).

In 2012, nearly 3 million injuries to and illnesses in private industry workers and 793,000 to and in state and local government workers were reported by employers (*3*). In the same year, an estimated 2.8 million work-related injuries were treated in emergency departments, resulting in 140,000 hospitalizations (National Institute for Occupational Safety and Health, CDC, unpublished data, 2014). Several national surveillance systems report new cases of nonfatal work-related injuries and illnesses, although no system captures all cases. Based on methods that focus on medical costs and productivity losses, the societal cost of work-related fatalities, injuries, and illnesses was estimated at $250 billion in 2007 (*2*). Methods that include consideration of pain and suffering would result in a higher estimated societal cost (*4*). CDC is working to better describe the burden of fatalities, injuries, and illnesses suffered by workers; additional information is available at http://www.cdc.gov/niosh/programs/econ/risks.html.

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Occupational Ladder Fall Injuries — United States, 2011

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Falls remain a leading cause of unintentional injury mortality nationwide, and 43% of fatal falls in the last decade have involved a ladder (*1*). Among workers, approximately 20% of fall injuries involve ladders (*2–4*). Among construction workers, an estimated 81% of fall injuries treated in U.S. emergency departments (EDs) involve a ladder (*5*). To fully characterize fatal and nonfatal injuries associated with ladder falls among workers in the United States, CDC's National Institute for Occupational Safety and Health (NIOSH) analyzed data across multiple surveillance systems: 1) the Census of Fatal Occupational Injuries (CFOI), 2) the Survey of Occupational Injuries and Illnesses (SOII), and 3) the National Electronic Injury Surveillance System–occupational supplement (NEISS-Work). In 2011, work-related ladder fall injuries (LFIs) resulted in 113 fatalities (0.09 per 100,000 full-time equivalent* [FTE] workers), an estimated 15,460 nonfatal injuries reported

* One full-time equivalent (FTE) worker = 2,000 hours worked per year.

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by employers that involved ≥1 days away from work (DAFW), and an estimated 34,000 nonfatal injuries treated in EDs. Rates for nonfatal, work-related, ED-treated LFIs were higher (2.6 per 10,000 FTE) than those for such injuries reported by employers (1.2 per 10,000 FTE). LFIs represent a substantial public health burden of preventable injuries for workers. Because falls are the leading cause of work-related injuries and deaths in construction, NIOSH, the Occupational Safety and Health Administration, and the Center for Construction Research and Training are promoting a national campaign to prevent workplace falls (*2*). NIOSH is also developing innovative technologies to complement safe ladder use (*6*).

The Bureau of Labor Statistics (BLS) administers the CFOI[†] each year to enumerate all fatal occupational injuries using multiple data sources. BLS also implements the annual SOII[§] to estimate injury and illness involving ≥1 DAFW from a nationally representative sample of employer-collected records. The NEISS-Work[¶] surveillance system estimates work-related injuries treated annually in EDs. LFI cases were identified using the Occupational Injury and Illness Classification System,[**] where the injury source was a ladder and the injury event was a fall to a lower level.

To calculate rates, labor force denominator estimates from the U.S. Current Population Survey (CPS)[††] for workers aged >15 years were used. Confidence intervals for NEISS-Work

[†] Analysis was conducted using restricted CFOI data that NIOSH receives through a memorandum of understanding. Results might differ from those released by BLS. To be considered an occupational fatality, the decedent of any age must have been employed at the time of the incident, working as a volunteer in the same capacity as a paid employee, or present at a site because of a job requirement.

[§] BLS posts SOII data on their website for public use (http://www.bls.gov/iif/home.htm). As a collaborative federal/state survey program, SOII includes reports from a nationally representative sample of approximately 220,000 private-sector employers. Information about the survey methodology is available at http://www.bls.gov/opub/hom/homch9.pdf.

[¶] NIOSH collects NEISS-Work data in collaboration with the Consumer Product Safety Commission (CPSC), which operates the base NEISS hospital system for the collection of data on consumer product–related injuries. NIOSH also collects the occupational injury data through collaboration with CPSC. However, there are no implied or expressed endorsements of the results presented herein by CPSC. The CPSC product-related injury estimates exclude work-related injuries, whereas NEISS-Work estimates include all work-related injuries regardless of product involvement (i.e., NEISS and NEISS-Work cases are mutually exclusive). From a stratified probability-based sample of 67 U.S. hospitals, injuries are determined to be work-related when the ED chart indicates an injury occurred to a noninstitutionalized civilian while working for pay or other compensation, working on a farm, or volunteering for an organized group.

[**] Occupational Injury and Illness Classification System version 2.01 was used to code cases obtained from CFOI and SOII. Version 1.01 was used to code cases obtained from NEISS-Work. Both versions are available at http://wwwn.cdc.gov/wisards/oiics.

[††] CPS is the primary source of U.S. labor force statistics. The U.S. Census Bureau surveys approximately 50,000 households monthly to collect employment, unemployment, earnings, hours of work, and other indicators. Variances for CPS labor force estimates were calculated using the BLS approximate standard error formulas derived for CPS. The variances for NEISS-Work data and CPS data were pooled to estimate the variance for injury rates.

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estimates accounted for the variance arising from the stratified cluster sample. The number, percentage, and rate of LFIs from CFOI, SOII, and NEISS-Work in 2011 were compared across demographic, work, and injury characteristics where available (Table).

Men and Hispanics had higher rates of fatal and nonfatal LFIs compared with women and non-Hispanic whites and persons of other races/ethnicities (Table). LFI rates increased with age, except for injuries treated in EDs. Fatality rates were substantially higher for self-employed workers (0.30 per 100,000 FTE workers) than salary/wage workers (0.06 per 100,000 FTE workers). Establishments with the fewest employees had the highest fatality rates. The construction industry had the highest LFI rates compared with all other industries. Across all industries, the highest fatal and nonfatal LFI rates were in the following two occupation groups: construction and extraction (e.g., mining) occupations, followed by installation, maintenance, and repair occupations. Head injuries were implicated in about half of fatal injuries (49%), whereas most nonfatal injuries involved the upper and lower extremities for employer-reported and ED-treated nonfatal injuries.

Severity of nonfatal LFIs was assessed using median DAFW (for employer-reported injuries) and disposition after ED treatment. Those with the highest median DAFW included men (21 days), workers aged 45–54 years (25 days), Hispanics (38 days), and construction and extraction workers (42 days). Workers with lower extremity (22 days) and multiple body part (28 days) injuries had higher median DAFW compared with other injuries. The hospital admission rate for ED-treated LFIs was 14%, almost three times the estimated overall hospital admission rate of 5% in the NEISS-Work survey for 2011, suggesting that LFIs were more severe compared with all other ED-treated injuries.

Fall height was documented for 82 of 113 fatalities and an estimated 11,400 of 34,000 nonfatal ED-treated LFIs (Figure). For nonfatal LFIs, nearly 90% were from heights <16 feet (<4.9 m) and fall heights of 6–10 feet (1.8–3.0 m) were most common, accounting for 50% of ED-treated LFIs. For fatal LFIs, fall heights of 6–10 feet (1.8–3.0 m) were most common but accounted for only 28% of all fatalities.

Discussion

Falls, particularly falls from ladders, contribute substantially to injuries in the workplace. To gain a comprehensive picture of the injury burden caused by ladder falls at work, cases from three different occupational surveillance systems were examined. Each system offers a different perspective on injuries. Current literature on LFIs indicates a higher burden of injuries to men, older workers, and construction workers (*4,5*). Although this analysis found similar results, it also indicated that Hispanics, self-employed workers, and workers in smaller establishments had disproportionately higher LFI rates. Higher rates of LFIs were identified in installation, maintenance, and repair occupations, in addition to construction and extraction workers. This report adds to the literature on occupational fall injuries by providing a comprehensive, multisystem view of LFIs across all occupational groups using the most recent surveillance data available in the United States. This analysis provides a baseline to the multiagency falls prevention campaign that started in 2012 (*2*).

The findings of this report are subject to at least four limitations. First, inclusion of cases is dependent on identifying the relationship between injury and work, which is not always clear, particularly for nonfatal injuries. Second, it is well recognized that nonfatal injury surveillance systems are subject to reporting and recording biases, which might result in underestimations of injury counts and rates (*7*). For example, not all demographic characteristics are pertinent to medical treatment, and therefore might be underreported during ED treatment. Such biases were minimal for CFOI because it is a census, rather than a sampled survey. Third, in this analysis, all workers were included in the denominator to calculate rates, which might underestimate the injury burden. A preferable denominator to understand LFI risk would be workers who used ladders in 2011, which might be available in future studies (*8*). Finally, this study is unable to evaluate adherence to safety recommendations.

Injuries from ladder falls can be severe but are preventable. Medical professionals might recommend safe ladder practices

What is already known on this topic?

Falls remain a leading cause of injury in the general population and among workers, particularly construction workers. Ladders contribute substantially to the public health burden of fall injuries, but most research in this area focuses on construction workers.

What is added by this report?

Analysis of data from three surveillance systems showed that in 2011, work-related ladder fall injuries (LFIs) resulted in 113 fatalities, an estimated 15,460 nonfatal injuries that involved ≥1 days away from work, and an estimated 34,000 nonfatal injuries treated in emergency departments. Workers who are male, Hispanic, older, self-employed, work in smaller establishments, and work doing construction and extraction or installation, maintenance, and repair experience higher LFI rates.

What are the implications for public health practice?

The findings of this study reinforce the need for workplace safety research to prevent falls, including developing and disseminating innovative technologies to prevent LFIs. Employers, health-care providers, and safety professionals should collaborate to ensure availability and training of safe ladder practices.

TABLE. Number, percentage, and rate of fatal and nonfatal occupational ladder fall injuries, by selected characteristics and data source — United States, 2011

	CFOI (fatalities)			SOII (nonfatal injuries reported by employers)						NEISS-Work (nonfatal injuries treated in EDs)				
Characteristic	No.	%[*]	Rate[†]	No.	(95% CI)	%[*]	Rate[§]	(95% CI)	Median DAFW[¶]	No.	(95% CI)	%[*]	Rate[**]	(95% CI)
Total	**113**	**100**	**0.09**	**15,460**	**(±550)**	**100**	**1.2**	**(±0.1)**	**20**	**34,000**	**(±6,800)**	**100**	**2.6**	**(±0.5)**
Sex														
Men	—[††]	—	—	12,510	(±470)	81	1.7	(±0.1)	21	30,100	(±6,300)	89	4	(±0.2)
Women	—	—	—	2,940	(±220)	19	0.5	(±0.1)	13	3,900	(±1,300)	11	0.7	(±0.2)
Age group (yrs)														
20–34	15	13	0.04	3,990	(±680)	26	1	(±0.2)	—	11,000	(±2,500)	32	2.7	(±0.5)
35–44	16	14	0.05	3,370	(±240)	22	1.1	(±0.1)	12	9,900	(±2,500)	29	3.3	(±0.6)
45–54	31	27	0.09	4,020	(±260)	26	1.2	(±0.1)	25	7,100	(±2,500)	21	2.2	(±0.5)
55–64	33	29	0.16	3,180	(±230)	21	1.5	(±0.2)	17	4,400	(±1,500)	13	2.1	(±0.5)
≥65	18	16	0.35	—		—	—		—	—		—	—	
Race/Ethnicity[§§]														
White, non-Hispanic	76	67	0.08	6,670	(±330)	43	0.7	(±0.1)	16	19,900	(±6,100)	59	2.2	(±0.4)
Other, non-Hispanic	8	7	0.04	—		—	—		—	2,000	(±1,000)	6	0.9	(±0.5)
Hispanic	29	26	0.15	2,460	(±200)	16	1.3	(±0.2)	38	5,800	(±2,800)	17	3.1	(±1.3)
Unknown	—	—	—	5,440	(±300)	35	—		15	—		—	—	
Employment status														
Employed (salary/wage)	73	65	0.06							27,800	(±5,600)	82	2.4	(±0.1)
Self-employed/farm/ family business/other	40	35	0.30							3,800	(±4,000)	11	2.8	(±1.1)
Establishment size[¶¶]														
1–19 employees	70	62	0.35											
20–99 employees	12	11	0.06											
≥100 employees	10	9	0.01											
Industry[*,†††]**														
Agriculture/forestry/fishing	—	—	—	—		—	—		—	—		—	—	
Mining	—	—	—	—		—	—		—	—		—	—	
Construction	64	57	0.74	3,600	(±390)	23	7.4		40	11,500	(±3,000)	34	13	(±2.5)
Manufacturing	9	8	0.06	1,160	(±110)	8	1.0		15	—		—	—	
Trade	—	—	—	2,770	(±220)	18	—		—	4,500	(±1,300)	13	2.5	(±0.6)
Transport/warehouse/utilities	—	—	—	—		—	—		—	—		—	—	
Services (excluding health care)	27	24	0.04	4,400	(±380)	29	—		—	5,200	(±1,600)	15	0.8	(±0.2)
Health care/social services	—	—	—	—		—	—		—	—		—	—	
Occupation[§§§]														
Management/business/finance	—	—	—	—		—	—		—	—		—	—	
Professional and related	—	—	—	—		—	—		—	—		—	—	
Service	14	12	0.06	2,520	(±370)	16	1	(±0.2)	—	1,900	(±700)	6	0.8	(±0.3)
Sales and related	—	—	—	1,390	(±150)	9	1	(±0.2)	17	2,200	(±1,000)	7	1.6	(±0.7)
Office/administrative support	—	—	—	—		—	—		—	—		—	—	
Farming/fishing/forestry	—	—	—	—		—	—		—	—		—	—	
Construction/extraction	57	50	0.83	3,510	(±240)	23	5.1	(±0.4)	42	10,700	(±2,900)	32	16	(±2.9)
Installation/maintenance/ repair	17	15	0.34	3,650	(±250)	24	7.3	(±0.6)	28	2,900	(±1,500)	9	5.7	(±2.6)
Production	8	7	0.10	—		—	—		—	—		—	—	
Transport/material moving	5	4	0.06	—		—	—		—	—		—	—	
Part of body injured[¶¶¶]														
Head	55	49	0.04	810	(±120)	5	0.1	(±0.1)	10	4,900	(±1,500)	14	0.4	(±0.1)
Trunk (chest/back/abdomen)	13	12	0.01	2,790	(±210)	18	0.2	(±0.1)	13	8,300	(±2,200)	24	0.6	(±0.1)
Upper extremities	—	—	—	3,280	(±230)	21	0.3	(±0.1)	15	9,400	(±2,400)	28	0.7	(±0.1)
Lower extremities	—	—	—	4,960	(±290)	32	0.4	(±0.1)	22	10,000	(±2,700)	29	0.8	(±0.1)
Multiple body parts	40	35	0.03	3,550	(±240)	23	0.3	(±0.1)	28	—		—	—	
Disposition														
Treated and released										29,200	(±6,000)	86	2.2	(±0.1)
Admitted										4,800	(±1,800)	14	0.4	(±0.1)

See table footnotes on page 345.

TABLE. (*Continued*) Number, percentage, and rate of fatal and nonfatal occupational ladder fall injuries, by selected characteristics and data source — United States, 2011

Abbreviations: CFOI = Census of Fatal Occupational Injuries; SOII = Survey of Occupational Injuries and Illnesses; NEISS-Work = National Electronic Injury Surveillance System–occupational supplement; ED = emergency department; CI = confidence interval; DAFW = days away from work; FTE = full-time equivalent; BLS = Bureau of Labor Statistics; RSE = relative standard error; NAICS = North American Industry Classification System; SOC = Standard Occupational Classification.

* Percentages might not sum to 100 because of exclusions and rounding.

† Per 100,000 FTE (FTE = 2,000 hours worked per year) per BLS publication requirements. Numbers of deaths are reported for workers of all ages, whereas rates are for workers aged ≥16 years. Rates were calculated by CDC based on the number of fatalities from restricted data from the BLS CFOI during 2011 and might differ from estimates published by BLS. The estimated number of primary employment FTE workers is based on the BLS Current Population Survey, 2011.

§ Per 10,000 FTE workers. Rates were calculated by CDC based on the number of injuries and the number of primary employment FTE workers from the BLS Current Population Survey, 2011. CIs were calculated based on BLS-reported RSE where available. Variances were summed for collapsed industry and occupation categories. CDC calculated rates might differ from estimates published by BLS.

¶ DAFW cases include injuries that result in ≥1 days away from work with or without restricted work activity.

** Per 10,000 FTE workers. Each injury is only counted once, regardless of the number of ED visits. Rates were calculated by CDC based on the number of injuries and the number of primary employed FTE workers from the BLS Current Population Survey, 2011. Variances for NEISS-Work data and CPS data were pooled to estimate the variance for injury rates.

†† Data did not meet criteria for publication without compromise of confidentiality.

§§ Persons of Hispanic ethnicity might be of any race or combination of races.

¶¶ Rates were calculated based on 2011 County Business Patterns (information available at http://www.census.gov/econ/susb).

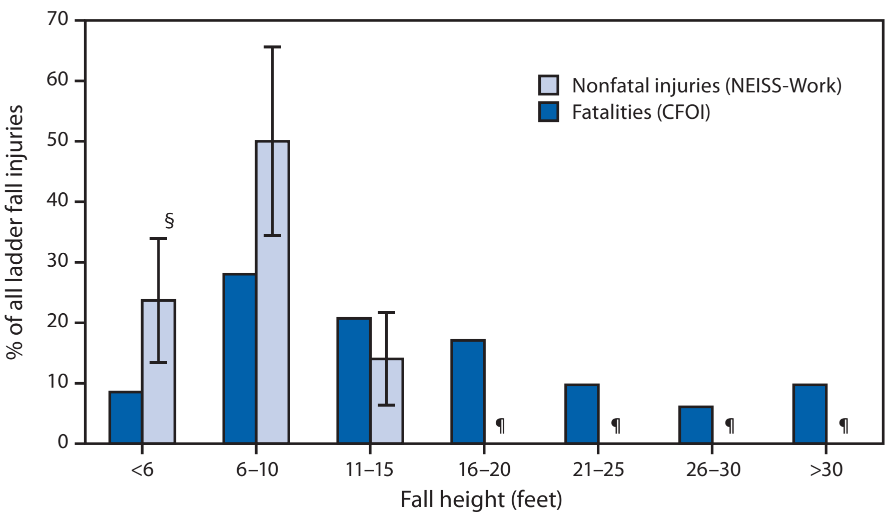
*** Industry in which the decedent worked was coded according to the 2007 NAICS (information available at http://www.census.gov/eos/www/naics). The detailed codes from the 20 NAICS sectors were combined into eight industry sectors according to the similarity of their occupational safety and health risks.

††† SOII industry counts, rates, and median DAFW were provided by BLS and are based on private industry only (excludes government employees).

§§§ Occupation in which the decedent worked was coded according to the 2010 SOC (available at http://www.blg.gov/soc). The detailed codes from the 22 civilian SOC groups were combined into 10 occupation groups according to the similarity of their occupational safety and health risks.

¶¶¶ Rates were calculated using all FTE workers as the denominator, based on the BLS Current Population Survey, 2011.

FIGURE. Percentage of ladder fall fatalities* and nonfatal ladder fall injuries treated in emergency departments,† by fall height (when documented) — United States, 2011



Abbreviations: CFOI = Census of Fatal Occupational Injuries; NEISS-Work = National Electronic Injury Surveillance System–occupational supplement; BLS = Bureau of Labor Statistics.

* Percentage of ladder fall fatalities were generated with restricted access to BLS CFOI microdata and might differ from results released by BLS. Fatality counts on which the percentages are calculated are based are 82 cases where ladder height was indicated and include deaths to workers of all ages, volunteer workers, and resident military personnel.

† Excludes 31 fatalities and 22,600 nonfatal injuries with unknown fall height.

§ 95% confidence interval.

¶ Nonfatal emergency department–treated injuries in this height category did not meet criteria for publication without compromise of confidentiality.

to their patients, such as those published by the American Academy of Orthopedic Surgeons as part of the Prevent Injuries Campaign (*9*). To prevent ladder falls, employers should consider the following steps: 1) plan the work to reduce or eliminate the need for using ladders by applying safety-in-design and constructability principles to finish as much of the work as possible on the ground; 2) provide alternative, safer equipment for extended work at elevation, such as aerial lifts, supported scaffolds, or mast climbing work platforms; 3) provide properly selected and thoroughly inspected ladders, that are well-matched to employee weight, task, and location; 4) when applicable, provide proper accessories to supplement safe ladder use; and 5) provide adequate ladder safety information and training for employees (*6,9*). Familiarity and compliance with the provisions of safety regulations, such as recognizing ladder types and conditions, and using ladder positioning and other safe ladder practices, are crucial to reducing injuries from ladder falls (*2*).

NIOSH safety research in this area focuses on innovative technologies to improve safe ladder use (*6*). For example, NIOSH recently developed and released a smartphone application (app) "Ladder Safety" (available at http://www.cdc.gov/niosh/topics/falls), which provides graphic-oriented, interactive, and easy-to-use reference materials, safety guidelines, and checklists for extension ladder selection, inspection, and use. The app is a convenient ladder safety performance and training tool and is available as a free download for Apple and Android mobile devices in English and Spanish (*10*).

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Indoor Firing Ranges and Elevated Blood Lead Levels — United States, 2002–2013

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Indoor firing ranges are a source of lead exposure and elevated blood lead levels (BLLs) among employees, their families, and customers, despite public health outreach efforts and comprehensive guidelines for controlling occupational lead exposure (*1*). There are approximately 16,000–18,000 indoor firing ranges in the United States, with tens of thousands of employees. Approximately 1 million law enforcement officers train on indoor ranges (*1*). To estimate how many adults had elevated BLLs (≥10 µg/dL) as a result of exposure to lead from shooting firearms, data on elevated BLLs from the Adult Blood Lead Epidemiology and Surveillance (ABLES) program managed by CDC's National Institute for Occupational Safety and Health (NIOSH) were examined by source of lead exposure. During 2002–2012, a total of 2,056 persons employed in the categories "police protection" and "other amusement and recreation industries (including firing ranges)" had elevated BLLs reported to ABLES; an additional 2,673 persons had non–work-related BLLs likely attributable to target shooting. To identify deficiencies at two indoor firing ranges linked to elevated BLLs, the Washington State Division of Occupational Safety and Health (WaDOSH) and NIOSH conducted investigations in 2012 and 2013, respectively. The WaDOSH investigation found a failure to conduct personal exposure and biologic monitoring for lead and also found dry sweeping of lead-containing dust. The NIOSH investigation found serious deficiencies in ventilation, housekeeping, and medical surveillance. Public health officials and clinicians should ask about occupations and hobbies that might involve lead when evaluating findings of elevated BLLs. Interventions for reducing lead exposure in firing ranges include using lead-free bullets, improving ventilation, and using wet mopping or high-efficiency particulate air (HEPA) vacuuming to clean (*1*).

ABLES Data, 2002–2012

In 2012, 41 states participated in ABLES, receiving notification from laboratories and physicians of elevated BLLs in persons aged ≥16 years through reporting mandated by state laws (*2*). Only the highest BLL was included if more than one was collected within a single year from an individual. Workers in the categories "police protection" or "other amusement and recreation industries" (OARI), which includes firing ranges, were considered to have occupational lead exposures.

During 2002–2012, a total of 2,056 persons in the two industry categories had BLLs ≥10 µg/dL; 785 had BLLs ≥25 µg/dL, and 1,271 had BLLs of 10–24 µg/dL. Of the 2,056, a total of 631 (31%) were employed in police protection, and 1,425 (69%) were employed in OARI (Table 1). During 2002–2012, non–work-related target shooting was the likely exposure for an additional 2,673 persons with elevated BLLs (1,290 with BLLs ≥25 µg/dL and 1,388 with BLLs of 10–24 µg/dL).

WaDOSH Investigation, 2012

In 2010, the Washington state ABLES program requested an inspection by WaDOSH of an indoor firing range after seven employees were found to have elevated BLLs. WaDOSH issued citations for violations of seven sections of their workplace lead standard, which is identical to the federal Occupational Safety and Health Administration (OSHA) standard.

In October 2012, the state ABLES program received reports of BLLs of 40 µg/dL and 48 µg/dL in two employees of the same range. Interviews revealed ongoing renovation at the range beginning in September 2012, including replacing the sand berm bullet trap with a steel bullet trap, replacing the ventilation system, and adding a second floor. Review of records revealed that from 2010 until the onset of renovation, 19 range employees had BLLs of 12–50 µg/dL. Following initial ABLES interviews, a compliance inspection from WaDOSH was conducted.

In the 2012 inspection, WaDOSH noted the ventilation system was inoperable and temporarily replaced by two roof fans that exhausted unfiltered air outside. Multiple citations were issued for violations of the workplace lead standard, including failure to conduct personal exposure and biologicmonitoring for lead, dry sweeping of lead-containing dust, and lack of respirator medical clearance and fit testing.

During renovation of the firing range, 117 construction workers and 42 range employees were present. A total of 98 of these persons received BLL testing, and 46 (47%) had elevated BLLs, including 26 construction workers (BLLs of 10–153 µg/dL) and 20 range employees (BLLs of 14–58 µg/dL). The BLL of 153 µg/dL was recorded approximately 10 weeks after the construction worker began dismantling the frame of the sand berm and installing the steel bullet trap. Interviews with nine construction workers and six range employees with

TABLE 1. Number and percentage* of adults with elevated blood lead levels (≥10 µg/dL), by selected categories — Adult Blood Lead Epidemiology and Surveillance (ABLES) program, United States, 2002–2012

	2002		2003		2004		2005		2006		2007	
Category	**No.**	**(%)**	**No.**	**(%)**	**No.**	**(%)**	**No.**	**(%)**	**No.**	**(%)**	**No.**	**(%)**
Adults with work-related exposures from firearm use, by industry subsector												
Police Protection, NAICS code 92212												
BLL ≥25 µg/dL	21	(0.3)	16	(0.2)	5	(0.1)	13	(0.2)	6	(0.1)	11	(0.2)
BLL 10–24 µg/dL	19	(0.3)	16	(0.2)	21	(0.3)	24	(0.3)	40	(0.5)	45	(0.6)
All Other Amusement and Recreation Industries, NAICS 71399 (including firing ranges)												
BLL ≥25 µg/dL	41	(0.6)	43	(0.6)	31	(0.5)	47	(0.8)	50	(0.7)	47	(0.7)
BLL 10–24 µg/dL	15	(0.2)	18	(0.3)	24	(0.3)	51	(0.7)	43	(0.5)	58	(0.7)
Total exposed at work (including non–firearm-related exposures)												
BLL ≥25 µg/dL	6,768	—	7,194	—	6,496	—	5,545	—	6,878	—	6,625	—
BLL 10–24 µg/dL	7,390	—	6,396	—	7,133	—	7,656	—	7,821	—	7,888	—
Adults with non–work-related exposures from firearm use												
Target shooting												
BLL ≥25 µg/dL	98	(24.9)	100	(27.8)	95	(31.3)	98	(30.2)	131	(34.0)	121	(34.0)
BLL 10–24 µg/dL	33	(18.4)	56	(24.8)	79	(25.8)	71	(26.3)	70	(21.0)	87	(20.8)
Total not exposed at work (including non–firearm-related exposures)												
BLL ≥25 µg/dL	393	—	360	—	304	—	325	—	385	—	356	—
BLL 10–24 µg/dL	179	—	226	—	306	—	270	—	334	—	419	—
Total with unknown source of exposure												
BLL ≥25 µg/dL	888	(11.0)	1,588	(17.4)	1,354	(16.6)	714	(10.8)	1,262	(14.8)	1,710	(19.7)
BLL 10–24 µg/dL	4,096	(35.1)	3,669	(35.7)	3,645	(32.9)	3,190	(28.7)	3,187	(28.1)	2,976	(26.4)
Total adults reported to ABLES (including non–firearm-related exposures)												
BLL ≥25 µg/dL	8,049	—	9,142	—	8,154	—	6,584	—	8,525	—	8,691	—
BLL 10–24 µg/dL	11,665	—	10,291	—	11,084	—	11,116	—	11,342	—	11,283	—
No. of states reporting exposure source†												
BLL ≥25 µg/dL	28	—	31	—	33	—	32	—	35	—	35	—
BLL 10–24 µg/dL	10	—	11	—	14	—	13	—	14	—	16	—

See footnotes on page 349.

What is already known on this topic?

Guidelines for the management of lead-exposed adults at or above the current CDC reference blood lead level (BLL) of 10 µg/dL are available. Despite public health outreach and comprehensive guidelines for controlling lead exposure in indoor firing ranges, these ranges continue to be a prominent source of lead exposure and elevated BLLs.

What is added by this report?

Data collected by the Adult Blood Lead Epidemiology and Surveillance program in 41 states during 2002–2012 identified 2,056 persons with BLLs ≥10 µg/dL who were likely exposed to firearms at work and an additional 2,673 persons likely exposed by non–work-related target shooting. Two investigations highlight the nature of lead exposure in firing ranges.

What are the implications for public health practice?

Employees and customers of indoor firing ranges, and their family members, continue to be exposed to hazardous amounts of lead. Lead exposures in firing ranges can be reduced by improving ventilation systems, use of wet mopping or high-efficiency particulate air vacuuming to remove dust and debris, and use of lead-free bullets. Public health practitioners, state and government agencies, and community organizations should be encouraged to increase lead exposure prevention efforts directed at employers, employees, and the community.

BLLs ≥40 µg/dL documented inadequate knowledge regarding the hazards of workplace and "take-home" lead exposures (e.g., lead transferred to family members via clothing or automobile interiors). As a result of this investigation, WaDOSH initiated standardized inspections of all firing ranges in the state, including exposure monitoring and lead safety training for firing range employees.

The state ABLES program advised employees to have family members tested; three children and two adult family members of four construction workers had BLLs ≥5 µg/dL. Positive tests for surface lead contamination in homes and vehicles of several workers required lead abatement from hard surfaces, carpeting, and upholstery. A recreational shooter at the range reported a BLL of 12.9 µg/dL to public health authorities.

NIOSH Investigation, 2013

In December 2013, at the request of employees, NIOSH investigators evaluated lead exposure at an indoor firing range and firearms retailer in California. Investigators reviewed medical and exposure records, interviewed five of the six employees, collected air and surface wipe samples for lead, and evaluated the ventilation systems for the range and showroom.

TABLE 1. (*Continued*) Number and percentage* of adults with elevated blood lead levels (≥10 µg/dL), by selected categories — Adult Blood Lead Epidemiology and Surveillance (ABLES) program, United States, 2002–2012

	2008		2009		2010		2011		2012		Total
Category	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.
Adults with work-related exposures from firearm use, by industry subsector											
Police Protection, NAICS code 92212											
BLL ≥25 µg/dL	9	(0.1)	14	(0.3)	15	(0.2)	9	(0.1)	13	(0.2)	**132**
BLL 10–24 µg/dL	67	(0.7)	75	(0.8)	67	(0.5)	71	(0.5)	54	(0.4)	**499**
All Other Amusement and Recreation Industries, NAICS 71399 (including indoor firing ranges)											
BLL ≥25 µg/dL	43	(0.6)	43	(0.8)	38	(0.6)	125	(1.8)	145	(2.5)	**653**
BLL 10–24 µg/dL	71	(0.8)	64	(0.7)	91	(0.7)	125	(0.9)	212	(1.6)	**772**
Total exposed at work (including non–firearm-related exposures)											
BLL ≥25 µg/dL	6,657	—	5,351	—	6,882	—	6,890	—	5,793	—	**71,079**
BLL 10–24 µg/dL	9,026	—	9,355	—	12,211	—	14,093	—	13,140	—	**101,962**
Adults with non–work-related exposures from firearm use											
Target shooting											
BLL ≥25 µg/dL	123	(35.9)	103	(30.4)	138	(39.4)	136	(33.8)	147	(37.5)	**1,290**
BLL 10–24 µg/dL	75	(17.3)	160	(28.7)	188	(25.5)	272	(31.3)	292	(38.2)	**1,383**
Total not exposed at work (including non–firearm-related exposures)											
BLL ≥25 µg/dL	343	—	339	—	350	—	402	—	392	—	**3,949**
BLL 10–24 µg/dL	433	—	557	—	738	—	869	—	764	—	**5,095**
Total with unknown source of exposure											
BLL ≥25 µg/dL	2,151	(23.5)	2,173	(27.6)	1,329	(15.5)	904	(11.0)	742	(10.7)	**14,815**
BLL 10–24 µg/dL	3,877	(29.1)	3,767	(27.5)	7,203	(35.7)	4,565	(23.4)	4,689	(25.2)	**44,864**
Total adults reported to ABLES (including non–firearm-related exposures)											
BLL ≥25 µg/dL	9,151	—	7,863	—	8,561	—	8,196	—	6,927	—	**89,843**
BLL 10–24 µg/dL	13,336	—	13,679	—	20,152	—	19,527	—	18,593	—	**152,068**
No. of states reporting exposure source†											
BLL ≥25 µg/dL	38	—	39	—	39	—	39	—	39	—	—
BLL 10–24 µg/dL	19	—	23	—	31	—	30	—	33	—	—

Abbreviations: BLL = blood lead level; NAICS = North American Industry Classification System.
* Percentage of the total reported per year by BLL group in the relevant category (e.g., in the industry subsector, it represents the proportion exposed at work).
† Fewer states provide work-relatedness and industry data for BLLs of 10–24 µg/dL, compared with BLLs ≥25 µg/dL.

Employees spent most of their work day on the sales floor or in the office, entering the range generally to assist shooters experiencing difficulty. Employees cleaned the range daily using a floor squeegee for spent bullet casings and a HEPA-filtered vacuum cleaner on carpeted areas. They replaced filters in the range exhaust ventilation system and scraped and oiled the steel bullet trap weekly.

Numerous deficiencies were found (Table 2). Six full-shift personal air samples from monitors worn by showroom employees had lead concentrations of 5.5–19 µg/m^3, within the current OSHA occupational exposure limit of 50 µg/m^3. Two task-based air samples for lead had high short-term (<1 hour) concentrations of 54 µg/m^3 (for nightly range maintenance) and 64 µg/m^3 (for weekly range cleaning). Lead was detected on all surfaces tested. Employee BLL testing had been conducted for the first time immediately before the NIOSH evaluation, and BLLs ranged from 19.9 µg/dL to 40.7 µg/dL. No employees had undergone other medical surveillance as required by the California Division of Occupational Safety and Health and OSHA (*3*). Recommendations were made to minimize employee and customer exposure to lead, and the county public health officer was notified regarding risks to customers from airborne and surface lead exposure. Employees were advised to send family members for BLL testing because of the potential for take-home lead exposures.

Discussion

The ABLES data and the two investigations summarized in this report document serious lead exposure from indoor firing ranges (*4*). Employers in general industry are required by law to follow the OSHA lead standard established in 1978 (*3,5*). OSHA considers the permissible airborne lead exposure limit of 50 µg/m^3 and allowable BLLs to be outdated (*5,6*).* The National Toxicology Program recently released a monograph on the potential health effects of low-level lead exposure to adults (*7*) (Table 3).

In 2013, the California Department of Public Health recommended that the California Division of Occupational Safety and Health lower the permissible exposure limit for lead in air

* The OSHA permissible exposure limit for airborne exposure to lead is 50 µg/m^3 of air for an 8-hour time-weighted average. The standard requires medical monitoring for employees exposed to airborne lead at or above the action level of 30 µg/m^3, medical removal of employees whose average BLL is ≥50 µg/dL for construction or 60 µg/dL for general industry, and economic protection for medically removed workers, among other things.

TABLE 2. Deficiencies contributing to elevated blood lead levels identified during the investigation of an indoor firing range — CDC's National Institute for Occupational Safety and Health, California, 2013

Deficiency type	Problem observed
Engineering control deficiencies	
Range ventilation system	Airflow at the firing line contained regions of backflow, causing lead to be carried back into the shooter's breathing zone instead of downrange.
	The range air supply diffusers produced turbulent jets of air, creating uneven air distribution at the firing line.
	The downrange airflow was not evenly distributed and did not have the minimum recommended airflow of 30 ft/min (15 cm/sec).
	The range filters did not have a minimum efficiency reporting value of 18 or 19, so contaminated air was released outside.
	The range filters did not have side and face gaskets to prevent air from bypassing the filter; this allowed lead-contaminated air to be distributed to other areas served by the ventilation system.
Building ventilation system	Openings in the wall between the firing range and the rest of the building allowed lead to be circulated throughout the building.
Housekeeping deficiencies	
Range housekeeping	Carpet and porous materials were present inside the shooting range.
	Uniforms worn by employees who cleaned the range were reused, laundered infrequently, and stored in an open storage room.
Building housekeeping	Lead was detected on carpets, desks, tables, counters, eating surfaces, and ventilation supply and return air ducts outside the range. It was also detected inside the clean clothing bins and on towels that had been laundered by a commercial launderer.
	Lead was detected on employees' shoes as they prepared to leave work.
	No showering facilities were available for employees.
	Employees' hands and street clothes were contaminated with lead.
Medical surveillance deficiencies	
Employees	No employees had undergone the required medical surveillance.
	The physician who evaluated employees to determine their fitness to wear a respirator did not complete the required forms properly.

to 0.5–2.1 μg/m^3 to keep BLLs below the range of 5–10 μg/dL (*8*). Guidelines for management of lead exposed employees (*9*) are endorsed by the California Department of Public Health, the Council of State and Territorial Epidemiologists, and the American College of Occupational and Environmental Medicine, and recommended by NIOSH (*1*). Importantly, these guidelines are not based on airborne lead levels, but on monitoring BLLs, which can reflect exposure through any route. BLLs should be kept below 10 μg/dL for all adults, and below 5 μg/dL for children and pregnant women (*9*).

The findings in this report also suggest that firing range customers and family members of firing range employees, in addition to employees themselves, can be exposed to hazardous amounts of lead. There are an estimated 19 million active target shooters in the United States (*10*).

The findings in this report are subject to at least five limitations. First, employers might not provide BLL testing to all lead-exposed employees as required. Second, adults with non–work-related exposures are not likely to be tested, and BLLs of recreational shooters are not consistently available. Third, certain laboratories might not report BLL test results as required. Fourth, how many of the elevated BLLs were related to firing range exposures is not known. Because the OARI industry category includes industries other than firing ranges (e.g., miniature golf courses and billiard parlors), it is possible that some OARI workers with occupational BLL elevations were not employed in firing ranges. Finally, the two investigations did not determine the full extent of take-home exposures and other sources of lead exposure among firing range workers and customers.

The number of persons with elevated BLLs from firearms use during 2011–2012 highlights the need to increase prevention activities. Airborne and surface lead levels in firing ranges can be greatly reduced by using lead-free bullets, improving ventilation systems, using wet mopping or HEPA vacuuming instead of dry sweeping, and having a written protocol for range maintenance (*1*). Measures also should be taken to prevent take-home exposure.[†]

[†] Measures to prevent take-home exposure include showering and changing into clean clothes after shooting or performing firing range maintenance activities, storing clean clothes in a separate bin from contaminated clothing, laundering of nondisposable outer protective clothing by a contractor or by the employer (not by the employee), and leaving at the range shoes worn inside the firing range, or providing disposable shoe coverings.

TABLE 3. National Toxicology Program (NTP) conclusions regarding evidence of the principal health effects of low-level lead exposures in adults — United States, 2013

Health area	BLL	Principal health effects	NTP conclusion regarding evidence
Neurologic	<10 µg/dL	Increased incidence of essential tremor	Sufficient
	<10 µg/dL	Psychiatric effects, decreased hearing, decreased cognitive function, increased incidence of amyotrophic lateral sclerosis	Limited
	<5 µg/dL	Increased incidence of essential tremor	Limited
Immune	Unclear	—	Inadequate
Cardiovascular	<10 µg/dL	Increased blood pressure and increased risk of hypertension	Sufficient
	<10 µg/dL	Increased cardiovascular-related mortality and electrocardiographic abnormalities	Limited
Renal	<5 µg/dL	Decreased glomerular filtration rate	Sufficient
Reproductive	<5 µg/dL	Women: reduced fetal growth	Sufficient
	≥15–20 µg/dL	Men: adverse changes in sperm parameters and increased time to pregnancy	Sufficient
	<10 µg/dL	Women: increase in spontaneous abortion and preterm birth	Limited
	≥10 µg/dL	Men: decreased fertility	Limited
	≥31 µg/dL	Men: spontaneous abortion in partner	Limited
	Unclear	Women and men: stillbirth, endocrine effects, birth defects	Inadequate

Adapted from: National Toxicology Program. Health effects of low-level lead evaluation. Research Triangle Park, NC: US Department of Health and Human Services, National Toxicology Program; 2013. Available at http://ntp.niehs.nih.gov/go/36443.

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Benefits from Immunization During the Vaccines for Children Program Era — United States, 1994–2013

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The Vaccines for Children (VFC) program was created by the Omnibus Budget Reconciliation Act of 1993 (*1*) and first implemented in 1994. VFC was designed to ensure that eligible children do not contract vaccine-preventable diseases because of inability to pay for vaccine and was created in response to a measles resurgence in the United States that resulted in approximately 55,000 cases reported during 1989–1991 (*2*). The resurgence was caused largely by widespread failure to vaccinate uninsured children at the recommended age of 12–15 months. To summarize the impact of the U.S. immunization program on the health of all children (both VFC-eligible and not VFC-eligible) who were born during the 20 years since VFC began, CDC used information on immunization coverage from the National Immunization Survey (NIS) and a previously published cost-benefit model to estimate illnesses, hospitalizations, and premature deaths prevented and costs saved by routine childhood vaccination during 1994–2013. Coverage for many childhood vaccine series was near or above 90% for much of the period. Modeling estimated that, among children born during 1994– 2013, vaccination will prevent an estimated 322 million illnesses, 21 million hospitalizations, and 732,000 deaths over the course of their lifetimes, at a net savings of $295 billion in direct costs and $1.38 trillion in total societal costs. With support from the VFC program, immunization has been a highly effective tool for improving the health of U.S. children.

Data from the 1980s suggested that measles outbreaks were linked to an ongoing reservoir of virus among high-density, low-income, inner-city populations (*2*). Although most children in these settings had a health-care provider, providers missed opportunities to give measles vaccine when children were in their offices, sometimes referring low-income children to another clinic where vaccines were available at no cost (*3*). Approximately 50% of children aged <19 years are eligible to receive vaccines through VFC (Immunization Services Division, National Center for Immunization and Respiratory Diseases, CDC, unpublished data, 2014).* Children can receive VFC-provided vaccine if they are Medicaid-eligible, uninsured, American Indian/Alaska Native, or, for underinsured children (i.e., whose health insurance does not fully cover immunizations), when they are receiving services at a federally qualified health center or rural health clinic (*1*). By providing vaccine for eligible children, at no charge, to public and private health-care providers who are enrolled in VFC, the program helped reinforce the "medical home." Inclusion of specific vaccines in VFC is determined by recommendations of the Advisory Committee on Immunization Practices (ACIP).

To assess improvements in coverage during the VFC era, data were obtained from the United States Immunization Survey (USIS) for the period 1967–1985, the National Health Interview Survey (NHIS) for 1991–1993, and NIS for 1994–2012 (*3,4*). Children included in USIS and NHIS were aged 24–35 months and those in NIS were aged 19–35 months. USIS and NHIS data were from parental recollection of vaccines received, and NIS data were obtained through provider report.

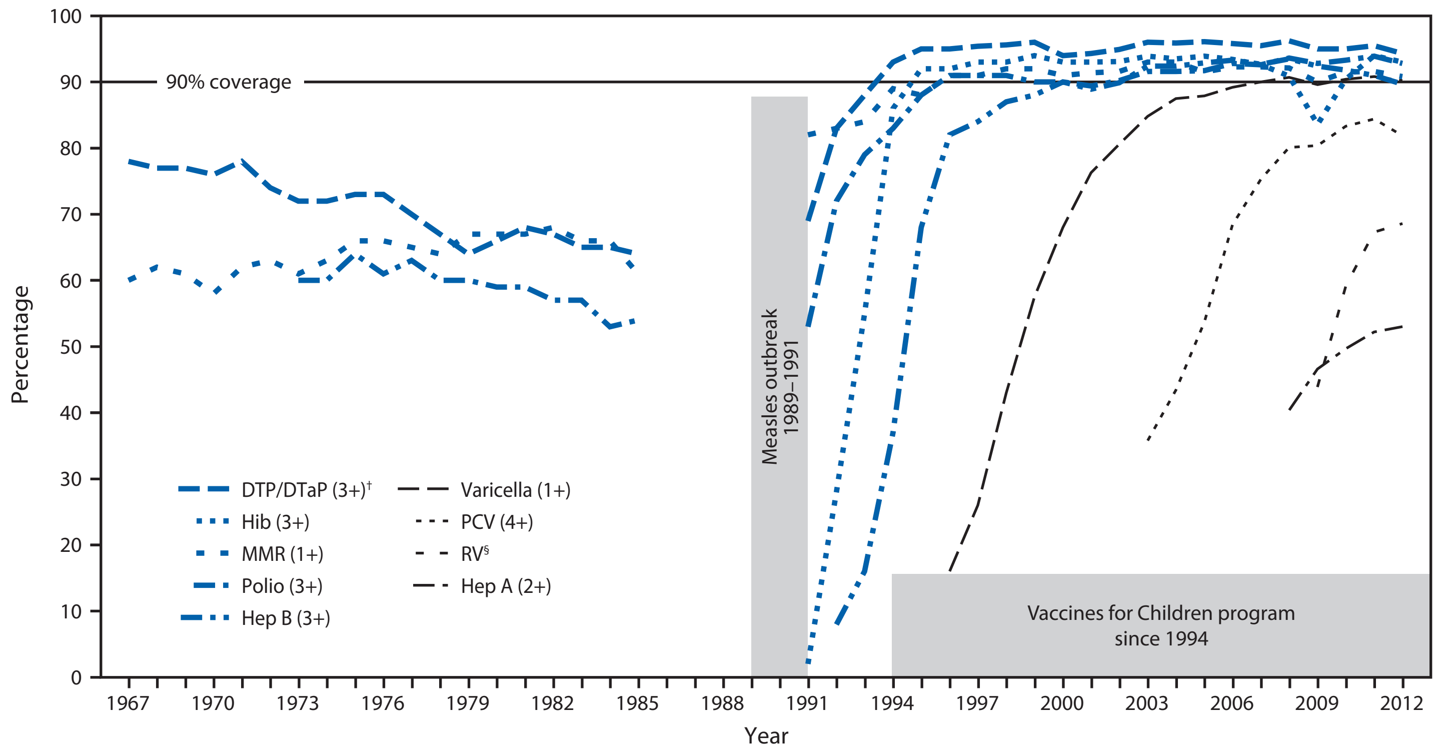
The cost-benefit model for U.S. children born during 1994–2013 employed methods previously used for children born in 2009 (*5*). A decision analysis birth cohort model was constructed using data on immunization coverage; vaccine efficacies from published literature; historical data on incidence of illnesses, hospitalizations, and deaths from vaccine-preventable diseases before immunization was introduced; and recent vaccination period data (through 2013, if available; otherwise 2012 data were used for 2013) on these same disease outcomes. Vaccines included all those universally recommended for children aged ≤6 years except influenza vaccine, which has been modeled separately (*6*), and hepatitis A vaccine. Infants in hypothetical birth cohorts from the period 1994–2013 were followed from birth through death. Benefits of immunization included savings in direct and indirect costs that accrued from averting illnesses, hospitalizations, and deaths among the 20 birth cohorts. Program costs included vaccine, administration, vaccine adverse events, and parent travel and work time lost. Costs were adjusted to 2013 dollars, and future costs related to disease were discounted at 3% annually. The cost analysis was conducted from both health-care (direct) and societal (direct and indirect) perspectives, and net present value (net savings) was calculated.†

When the VFC program began in 1994, vaccines targeting nine diseases were provided: diphtheria, tetanus, pertussis, polio, *Haemophilus influenzae* type b disease, hepatitis B, measles, mumps, and rubella (Figure). During 1995–2013, five vaccines were added for children aged ≤6 years: varicella

* Additional information available at http://www.cdc.gov/vaccines/programs/vfc/awardees/program-management/surveys/pes-estimates.html.

† Additional information available at http://www.cdc.gov/vaccines/programs/vfc/pubs/methods/.

FIGURE. Vaccine coverage rates among preschool-aged children* — United States, 1967–2012



Abbreviations: DTP/DTaP = diphtheria, tetanus, pertussis or diphtheria, tetanus, acellular pertussis; MMR = measles, mumps, and rubella; Hib = *Haemophilus influenzae* type b; Hep B = hepatitis B; PCV = pneumococcal conjugate vaccine; RV = rotavirus vaccine; Hep A = hepatitis A.

Sources: United States Immunization Survey (1967–1985), National Health Interview Survey (1991–1993), and National Immunization Survey (1994–2012). No data are available for 1986–1990.

* Children in the United States Immunization Survey and National Health Interview Survey were aged 24–35 months. Children in the National Immunization Survey were aged 19–35 months.

† Numbers in parentheses refer to the number of doses of that vaccine being tracked in this figure.

§ For rotavirus vaccine, 2 or 3 doses are tracked, depending on the type of rotavirus vaccine received.

(1996), hepatitis A (1996–1999 for high-risk areas, 2006 for all states), pneumococcal disease (7-valent in 2000, 13-valent in 2010), influenza (ages 6–23 months in 2004 and ages 6–59 months in 2006), and rotavirus vaccine (2006). Since 1996, coverage with 1 dose of a measles-containing vaccine has exceeded *Healthy People*§ targets of 90%, up from <70% before the 1989–1991 outbreak (Figure). For other vaccines licensed before VFC, coverage also was higher in the VFC era, as measured by NIS, than in the pre-VFC era, as measured by USIS. In general, coverage for new vaccines introduced during the VFC era increased rapidly.

Among 78.6 million children born during 1994–2013, routine childhood immunization was estimated to prevent 322 million illnesses (averaging 4.1 illnesses per child) and 21 million hospitalizations (0.27 per child) over the course of their lifetimes and avert 732,000 premature deaths from vaccine-preventable illnesses (Table). Illnesses prevented

§ Additional information available at http://www.healthypeople.gov/2020/topicsobjectives2020/objectiveslist.aspx?topicId=23.

What is already known on this topic?

Vaccination is one of the most effective public health interventions. The Vaccines for Children (VFC) program was created by the Omnibus Budget Reconciliation Act of 1993 and implemented in 1994. VFC was created in response to low immunization coverage and the 1989–1991 measles outbreak in the United States.

What is added by this report?

In the 20 years since the VFC program was implemented, five new vaccines have been added to the routine infant immunization program, increasing the number of diseases prevented to 14. Vaccination coverage has remained near or above 90% for older vaccines. Because of vaccination, approximately 322 million illnesses, 21 million hospitalizations, and 732,000 premature deaths will be prevented among children born during this period, at a cost savings to society of $1.38 trillion.

What are the implications for public health practice?

The findings indicate the ongoing importance of maintaining and monitoring the U.S. immunization program.

TABLE. Estimated number of illnesses, hospitalizations, and deaths prevented by routine childhood immunization for selected vaccine-preventable diseases among children born during the Vaccines for Children era — United States, 1994–2013

	Cases prevented (in thousands)		
Vaccine-preventable disease*	**Illnesses**	**Hospitalizations**	**Deaths**
Diphtheria	5,073	5,073	507.3
Tetanus	3	3	0.5
Pertussis	54,406	2,697	20.3
Haemophilus influenzae type B	361	334	13.7
Polio	1,244	530	14.8
Measles	70,748	8,877	57.3
Mumps	42,704	1,361	0.2
Rubella	36,540	134	0.3
Congenital rubella syndrome	12	17	1.3
Hepatitis B	4,007	623	59.7
Varicella	68,445	176	1.2
Pneumococcus-related diseases†	26,578	903	55.0
Rotavirus	11,968	327	0.1
Total	**322,089**	**21,055**	**731.7**

* Vaccines were considered as preventing disease for birth cohorts born in all years during 1994–2013 except for the following, which were only in use for part of the 20-year period: varicella, 1996–2013; 7-valent and 13-valent pneumococcal conjugate vaccines, 2001–2013; and rotavirus, 2007–2013.
† Includes invasive pneumococcal disease, otitis media, and pneumonia.

ranged from 3,000 for tetanus to >70 million for measles. The highest estimated cumulative numbers of hospitalizations and deaths that will be prevented were 8.9 million hospitalizations for measles and 507,000 deaths for diphtheria. The routine childhood vaccines introduced during the VFC era (excluding influenza and hepatitis A) together will prevent about 1.4 million hospitalizations and 56,300 deaths.

Vaccination will potentially avert $402 billion in direct costs and $1.5 trillion in societal costs because of illnesses prevented in these birth cohorts. After accounting for $107 billion and $121 billion in direct and societal costs of routine childhood immunization, respectively, the net present values (net savings) of routine childhood immunization from the payers' and societal perspectives were $295 billion and $1.38 trillion, respectively.

Discussion

This report shows the strength of the U.S. immunization program since VFC began; coverage with new vaccines increased rapidly after introduction, and coverage for older childhood vaccines remains near or above 90%. The ability of VFC to remove financial and logistical barriers hindering vaccination for low-income children likely played a significant role in obtaining high coverage. Successful delivery of vaccines to children of all income levels relies on participation of public and private health-care providers, insurance companies, state and federal public health officials, vaccine manufacturers, and parents. For pediatric health-care providers, VFC supported the "medical home" and reduced barriers to integrated, quality pediatric care with immunizations as the backbone of well-child visits. VFC also supports state-based immunization programs, which have transitioned from service delivery in public health clinics to quality assurance of private sector immunization and oversight of approximately 90 million VFC and other public sector doses distributed annually (Immunization Services Division, National Center for Immunization and Respiratory Diseases, CDC, unpublished data, 2013).

This analysis demonstrates the large number of illnesses, hospitalizations, and deaths prevented by childhood immunization. Because of sustained high coverage, many vaccine-preventable diseases are now uncommon in the United States. Measles was declared no longer endemic in the United States in 2000 (*2*), in contrast to model estimates that 71 million cases would have occurred in children born in the VFC era without immunization. Economic analysis for 2009 alone found that each dollar invested in vaccines and administration, on average, resulted in $3 in direct benefits and $10 in benefits when societal costs are included (*5*). Although the data presented here were generated with U.S. disease estimates and costs, the benefits are relevant to other countries where policymakers are considering return on investment in their immunization programs.

The model estimated more illnesses prevented by vaccination during the lifetimes of 20 birth cohorts than a report published in 2013 that found 26 million illnesses prevented in the U.S. population over the last decade (*7*) and a report published in 2007 that found prevention of 1 million to 2 million illnesses per year (*8*). These earlier assessments used disease reported through passive public health systems for baseline burden estimates, did not adjust for the increase in U.S. population over time, and assessed fewer vaccines than the model presented here, all factors that could explain their lower estimates.

The findings in this report are subject to at least three limitations. First, the benefits of hepatitis A vaccine, annual childhood influenza vaccine, and adolescent vaccines were not included. Second, the model did not account for all indirect vaccine effects on disease burden; for some vaccines, reduced transmission to unvaccinated populations has been a powerful driver of cost-effectiveness (*9*). Finally, for some diseases such as diphtheria, factors other than immunization might have contributed to lower disease risks in recent decades, and reductions resulting from these contributions have not been incorporated into the model; if such reductions were substantial, the model would overestimate the vaccine-preventable burden. However, a sensitivity analysis of the 2009 birth cohort model using the same methods suggested that, even with "worst case scenario" assumptions, early childhood immunization was cost-saving (*5*).

Although VFC has strengthened the U.S. immunization program, ongoing attention is needed to ensure that the program addresses challenges and incorporates methods that could improve delivery. Approximately 4 million children are born in the United States each year, each of whom is vulnerable to vaccine-preventable pathogens that continue to circulate. Importations from areas where measles is endemic are an ongoing challenge for public health workers and clinicians. Coverage with human papillomavirus vaccine for adolescent girls has not yet reached optimal levels. Essential program functions such as monitoring vaccine safety, coverage, and effectiveness and managing supply interruptions need ongoing attention, although the VFC stockpile has helped mitigate the impact of shortages (*10*). VFC, in conjunction with provisions of the Affordable Care Act that eliminate many co-payments for ACIP-recommended vaccines, minimizes financial barriers and thereby helps protect children from vaccine-preventable diseases.

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Surveillance Systems to Track Progress Toward Global Polio Eradication — Worldwide, 2012–2013

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In 2012, the World Health Assembly of the World Health Organization (WHO) declared completion of polio eradication a programmatic emergency (*1*). Polio cases are detected through surveillance of acute flaccid paralysis (AFP) cases and subsequent testing of stool specimens for polioviruses (PVs) at WHO-accredited laboratories within the Global Polio Laboratory Network (GPLN). AFP surveillance is supplemented by environmental surveillance, testing sewage samples from selected sites for PVs. Virologic surveillance, including genomic sequencing to identify isolates by genotype and measure divergence between isolates, guides Global Polio Eradication Initiative (GPEI) activities by confirming the presence of PV, tracking chains of PV transmission, and highlighting gaps in AFP surveillance quality. This report provides AFP surveillance quality indicators at national and subnational levels during 2012–2013 for countries that experienced PV cases during 2009–2013 in the WHO African Region (AFR) and Eastern Mediterranean Region (EMR), the remaining polio-endemic regions (*2*). It also summarizes the results of environmental surveillance and reviews indicators assessing the timeliness of reporting of PV isolation and of virus strain characterization globally. Regional-level performance indicators for timely reporting of PV isolation were met in five of six WHO regions in 2012 and 2013. Of 30 AFR and EMR countries that experienced cases of PV (wild poliovirus [WPV], circulating vaccine-derived poliovirus [cVDPV], or both) during 2009–2013, national performance indicator targets for AFP surveillance and collection of adequate specimens were met in 27 (90%) countries in 2012 and 22 (73%) in 2013. In 17 (57%) countries, ≥80% of the population lived in subnational areas meeting both AFP performance indicators in 2012, decreasing to 13 (43%) in 2013. To achieve polio eradication and certify interruption of PV transmission, intensive efforts to strengthen and maintain AFP surveillance are needed at subnational levels, including in field investigation and prompt collection of specimens, particularly in countries with current or recent active PV transmission.

AFP Surveillance

Paralysis, the long-lasting manifestation of clinical poliomyelitis, is a rare outcome of WPV and cVDPV infections (<1%). AFP surveillance detects recent acute paralytic illness of any cause, including poliomyelitis caused by WPV or VDPV. Standardized GPEI performance indicators are used to evaluate the quality of AFP surveillance and changes over time and to identify surveillance gaps where PV transmission might go undetected. The indicator used to determine if surveillance is sufficiently sensitive to detect PV circulation is the annual proportion of AFP cases that are negative for WPV and VDPV (nonpolio AFP [NPAFP]) among children aged <15 years. Countries in WHO regions certified as polio-free* should achieve an annual NPAFP rate of ≥1 case per 100,000 population aged <15 years; all other countries† should achieve annual rates of ≥2 cases per 100,000. To ensure sufficiently complete and reliable laboratory analysis, ≥80% of AFP cases should have two stool specimens collected within 14 days of paralysis onset, ≥24 hours apart, arriving in good condition at an accredited GPLN laboratory ("adequate" specimens). Because national data can mask heterogeneous subnational performance, AFP surveillance quality indicators are applied to subnational areas, and the proportion of the national population residing in subnational areas where both indicator targets are met was assessed (Table 1, Figure).

In 2012, AFP surveillance detected WPV transmission in five countries, including three countries with uninterrupted, endemic WPV transmission (Afghanistan, Nigeria, and Pakistan), one previously polio-free country with reestablished WPV transmission (Chad), and one polio-free country with an outbreak after importation (Niger) (Table 1). In 2013, WPV cases were detected in eight countries, including the three countries with endemic WPV (Afghanistan, Nigeria, and Pakistan), and five countries affected by outbreaks after importation (Cameroon, Ethiopia, Kenya, Somalia, and Syria). All WPV cases were type 1 (WPV1).

cVDPV-associated polio cases were detected in eight AFR and EMR countries in 2012 (Afghanistan, Chad, Democratic Republic of the Congo [DRC], Kenya, Nigeria, Pakistan, Somalia, and Yemen) and in eight countries in 2013 (Afghanistan, Cameroon, Chad, Niger, Nigeria, Pakistan, Somalia, and Yemen) (Table 1) (*3*). All cVDPVs isolated from persons with AFP during 2012 and 2013 were type 2, except for those in Yemen (type 3).

* American, European, South-East Asia, and Western Pacific regions. Data for countries of these regions and regional values are available at http://www.who.int/vaccines/immunization_monitoring/en/diseases/poliomyelitis/case_count.cfm.

† Countries in the African and Eastern Mediterranean regions. Although the South-East Asia Region has been recently certified polio-free, countries are still expected to reach the two or more NPAFP rate standard.

Of 25 AFR countries with PV transmission during 2009–2013, the NPAFP national target was met in all countries in 2012, and all except Gabon in 2013. The national target for adequate specimen collection was met in all countries except Cameroon and Gabon in 2012, and in all except Cameroon, Ethiopia, Gabon, Guinea, Niger, Republic of the Congo, and Senegal in 2013. Twelve of the 25 countries had all subnational areas meeting the subnational NPAFP rate target in 2012 or in 2013. Only three of the 25 countries had all subnational areas reporting adequate specimen collection in 2013, compared with 10 in 2012. (Table 1, Figure). In only nine (36%) countries, ≥80% of the population lived in areas meeting both subnational indicators during both 2012 and 2013 (Benin, Côte d'Ivoire, Liberia, Mali, Mauritania, Mozambique, Nigeria, South Sudan, and Togo).

Of five EMR countries that experienced PV transmission during 2009–2013, only Syria in 2012 and 2013 failed to meet the national target for NPAFP rate, and only Syria failed to meet the national standard for specimen adequacy in 2013. However, only two of the five had all subnational areas meeting the target for NPAFP rate in 2012 and three of the five in 2013; one country in each year had all subnational areas reporting adequate specimen collection. Nonetheless, the target of having ≥80% of the population living in areas meeting both subnational indicators was reached in all polio-affected countries in EMR during 2012–2013, except Somalia and Syria in 2012 and Syria in 2013.

What is already known on this topic?

Polio cases are detected through surveillance of acute flaccid paralysis (AFP) cases with stool specimens tested for polioviruses (PVs) at accredited laboratories within the Global Polio Laboratory Network. Some countries also test for polioviruses in samples taken from sewage. Genomic sequence analysis allows the Global Polio Eradication initiative to monitor pathways of PV transmission, both of wild poliovirus (WPV) and circulating vaccine-derived poliovirus (cVDPV).

What is added by this report?

Of 30 countries in the World Health Organization African and Eastern Mediterranean regions with transmission of WPV or cVDPV during 2009–2013, those meeting national performance indicator targets for AFP surveillance and collection of adequate specimens declined from 27 (90%) in 2012 to 22 (73%) in 2013, primarily because of surveillance weaknesses in the African Region. The number of subnational areas meeting both AFP performance indicators in 2012 and 2013 also declined in many countries of the African Region. Environmental surveillance often found evidence of PV circulation in the absence of detected AFP cases.

What are the implications for public health practice?

WPV outbreaks in previously polio-free countries in Africa and the Middle East are reminders that all countries remain at risk as long as WPV continues to circulate in any one country. Intensive efforts are needed to strengthen and maintain AFP surveillance, including analysis of the reasons for surveillance weaknesses, training of surveillance staff, and enhanced supervision in field investigation and collection of specimens, in countries with current or recent active poliovirus transmission.

Environmental Surveillance

The sampling and testing of sewage complements AFP surveillance by identifying PV transmission that might occur in the absence of detected AFP cases (*2*). Environmental surveillance has been established in WPV-endemic countries (Afghanistan since September 2013, Nigeria since 2011, and Pakistan since 2009) and in countries without active WPV transmission currently (India, Egypt, and 19 countries in the WHO European Region). Active WPV1 transmission without detection of polio cases was identified in Israel, the West Bank, and Gaza in 2013 (*4,5*). Genomic sequencing and phylogenetic analyses indicate that the WPV1 originated in Pakistan and is closely linked to WPV1 isolated from two sewage specimens collected in December 2012 in Cairo, Egypt (*2*) and to WPV1 cases detected in 2013 in Syria (*6,7*), indicating widespread circulation in the Middle East during the end of 2012 and early 2013. In Afghanistan, no WPV or VDPV have been detected in the few samples collected in Kandahar city and tested since September 2013.

In Nigeria, sampling is currently conducted at 29 sites in seven states and the Federal Capital Territory. In 2012, WPV1 was isolated from two sewage samples from Kano state, and from multiple samples from Sokoto state when WPV-confirmed AFP cases were widely reported in both states. In 2013, WPV1 was isolated from one sewage sample in Kano (February), from three samples collected in Sokoto (March–April), and one sample collected from a new site in Borno state (October). Continued VDPV2 circulation and transmission of cVDPV2 imported from Chad was documented during 2012–2013 through VPDV2 isolation from samples collected in Sokoto (continued circulation), and in Kano and Borno (Chad-related). No WPV or VDPV has been detected at environmental surveillance sites established in 2013 in other Nigerian states.

In Pakistan, sampling is currently conducted at 27 sites in four provinces. The overall proportion of sewage samples positive for WPV1 decreased from 67% in 2011 to 20% in 2013. Environmental surveillance detected continuous WPV1 circulation in Hyderabad (in southern Sindh Province) into mid-2013, without any corresponding WPV1-confirmed AFP case reported in the same area for >12 months. During 2013, WPV1 was isolated sporadically from samples collected in Quetta, Karachi, and from sites in Punjab Province.

Global Polio Laboratory Network

The GPLN consists of 146 WHO-accredited PV laboratories in all WHO regions. GPLN member laboratories follow

TABLE 1. National and subnational acute flaccid paralysis (AFP) surveillance indicators and number of confirmed wild poliovirus (WPV) and circulating vaccine-derived poliovirus (cVDPV) cases, among countries with poliovirus transmission during 2009–2013 within the African and Eastern Mediterranean regions of the World Health Organization (WHO) and regional indicators, 2012 and 2013.*

	2012							
WHO region/Country[†]	AFP cases	Regional/ National NPAFP rate[§]	Subnational areas with NPAFP rate ≥2 (%)	Regional/ National AFP cases with adequate specimens[¶] (%)	Subnational areas with ≥80% adequate specimens (%)	Population in areas meeting both subnational indicators** (%)	Confirmed WPV cases[††]	Confirmed cVDPV cases[§§]
African	18,075	4.8	—	(90)	—	—	128	40
Angola	319	3.1	(94)	(92)	(100)	(98)	—	—
Benin	153	3.6	(92)	(92)	(92)	(87)	—	—
Burkina Faso	321	4.0	(93)	(89)	(100)	(100)	—	—
Burundi	117	2.9	(71)	(98)	(100)	(72)	—	—
Cameroon	336	2.8	(100)	(79)	(60)	(56)	—	—
CAR	124	6.0	(100)	(85)	(86)	(88)	—	—
Chad	418	6.7	(100)	(82)	(67)	(67)	5	12
Côte d'Ivoire	406	4.3	(100)	(83)	(83)	(85)	—	—
DRC	1,867	4.4	(100)	(86)	(91)	(86)	—	17
Ethiopia	1,156	2.8	(91)	(85)	(55)	(69)	—	—
Gabon	25	2.5	(63)	(76)	(75)	(16)	—	—
Guinea	187	3.3	(100)	(97)	(100)	(100)	—	—
Kenya	714	4.2	(100)	(92)	(100)	(100)	—	3
Liberia	56	3.2	(73)	(100)	(100)	(70)	—	—
Mali	266	3.4	(75)	(94)	(88)	(92)	—	—
Mauritania	78	5.7	(100)	(95)	(100)	(100)	—	—
Mozambique	320	3.1	(100)	(89)	(100)	(100)	—	—
Niger	368	4.3	(88)	(80)	(50)	(55)	1	—
Nigeria[§§]	7,239	8.7	(100)	(95)	(97)	(96)	122	8
Republic of the Congo	58	2.7	(64)	(84)	(64)	(19)	—	—
Senegal	160	2.7	(73)	(81)	(55)	(50)	—	—
Sierra Leone	168	6.3	(75)	(95)	(100)	(79)	—	—
South Sudan	325	4.3	(100)	(95)	(90)	(97)	—	—
Togo	94	2.9	(100)	(97)	(100)	(100)	—	—
Uganda	472	3.2	(65)	(88)	(71)	(52)	—	—
Eastern Mediterranean	11,119	5.2	—	(91)	—	—	95	28
Afghanistan	1,829	10.2	(100)	(92)	(94)	(91)	37	9
Pakistan	5,036	5.6	(88)	(89)	(88)	(98)	58	16
Somalia	148	2.8	(79)	(98)	(100)	(56)	—	1
Syria	109	1.1	(15)	(85)	(62)	(10)	—	—
Yemen	474	4.0	(100)	(93)	(95)	(98)	—	2

See footnotes on page 359.

standardized protocols to 1) isolate and identify PVs, 2) differentiate the three PV serotypes, and 3) characterize PVs as WPV, Sabin-like PV, and VDPV by intratypic differentiation [ITD]) (*8*) and genomic sequencing. Results of sequencing are also used to monitor pathways of PV transmission by comparing the nucleotide sequence of the VP1 region of the genomes from PV isolates. The two standard laboratory timeliness indicators for stool specimen processing are that laboratories should report ≥80% of PV isolation results within 14 days of receiving samples and ≥80% of ITD results within 7 days of receipt of isolates. The programmatic indicator standard combining field and laboratory performance is to report ITD results for ≥80% of isolates within 60 days of paralysis onset of AFP cases. This indicator takes into account the entire interval from onset of paralysis through case notification, investigation, and specimen collection, transport, and testing (EMR uses a 45-day timeframe). In addition to timeliness, the accuracy and quality of testing at GPLN member laboratories is monitored through an annual accreditation program of onsite reviews and proficiency testing for viral isolation, ITD, and sequencing procedures.

During 2012–2013, GPLN laboratories met timeliness indicators for PV isolation in five of six WHO regions in each year (Table 2) and reporting indicators for receipt to ITD results in five of six regions in 2012 and all regions in 2013. The overall timeless indicator for onset to ITD results was met in all regions in both years. The GPLN tested a total of 215,629 stool specimens collected from persons with AFP in 2012 and 197,658 in 2013. In 2013, an additional 10,871 stool specimens from contacts of AFP cases, 3,223 stool specimens from other investigations, and 2,537 environmental samples were tested. In 2012, 395 WPV isolates were detected from AFP samples compared with 723 detected in 2013 (an 83% increase). In addition, 125 VDPV isolates were detected from AFP cases in 2012, compared with 65 VDPV isolates detected in 2013 (a 52% decrease).

TABLE 1. (*Continued*) National and subnational acute flaccid paralysis (AFP) surveillance indicators and number of confirmed wild poliovirus (WPV) and circulating vaccine-derived poliovirus (cVDPV) cases, among countries with poliovirus transmission during 2009–2013 within the African and Eastern Mediterranean regions of the World Health Organization (WHO) and regional indicators, 2012 and 2013.*

	2013							
WHO region/Country†	AFP cases	Regional/ National NPAFP rate§	Subnational areas with NPAFP rate ≥2 (%)	Regional/ National AFP cases with adequate specimens¶ (%)	Subnational areas with ≥80% adequate specimens (%)	Population in areas meeting both subnational indicators** (%)	Confirmed WPV cases††	Confirmed cVDPV cases§§
African	20,264	5.3	—	(91)	—	—	80	13
Angola	310	2.9	(89)	(92)	(94)	(79)	—	—
Benin	180	4.3	(100)	(91)	(92)	(95)	—	—
Burkina Faso	292	3.7	(86)	(85)	(71)	(65)	—	—
Burundi	96	2.4	(59)	(91)	(88)	(49)	—	—
Cameroon	483	4.3	(100)	(77)	(30)	(25)	4	4
CAR	60	2.6	(57)	(90)	(71)	(36)	—	
Chad	500	8.6	(100)	(82)	(56)	(56)	—	4
Côte d'Ivoire	455	4.9	(100)	(88)	(83)	(87)	—	—
DRC	2,011	4.8	(100)	(83)	(73)	(70)	—	—
Ethiopia	1,164	2.8	(64)	(71)	(9)	(0)	9	—
Gabon	6	0.6	(67)	(17)	(0)	(0)	—	—
Guinea	224	4.0	(100)	(54)	(0)	(0)	—	—
Kenya	637	3.5	(88)	(84)	(88)	(65)	14	—
Liberia	50	2.9	(80)	(98)	(100)	(86)	—	—
Mali	243	3.1	(88)	(88)	(88)	(96)	—	—
Mauritania	58	4.2	(100)	(93)	(85)	(90)	—	—
Mozambique	333	3.3	(100)	(89)	(80)	(85)	—	—
Niger	338	4.1	(100)	(75)	(25)	(8)	—	1
Nigeria§§	8,641	10.5	(100)	(96)	(100)	(100)	53	4
Republic of the Congo	106	5.2	(100)	(79)	(64)	(78)	—	—
Senegal	231	3.7	(91)	(68)	(18)	(7)	—	—
Sierra Leone	171	6.4	(60)	(92)	(100)	(79)	—	—
South Sudan	295	3.8	(90)	(94)	(90)	(87)	—	—
Togo	155	4.7	(100)	(85)	(83)	(87)	—	—
Uganda	486	3.3	(71)	(87)	(77)	(51)	—	—
Eastern Mediterranean	11,520	5.2	—	(90)	—	—	327	50
Afghanistan	1,897	10.8	(100)	(94)	(97)	(97)	14	3
Pakistan	4,778	5.2	(88)	(90)	(100)	(99)	93	45
Somalia	546	6.4	(100)	(88)	(89)	(93)	194	1
Syria	171	1.3	(15)	(64)	(38)	(4)	25	—
Yemen	614	5.2	(100)	(92)	(91)	(84)	—	1

Abbreviations: NPAFP = nonpolio AFP; DRC = Democratic Republic of the Congo; CAR = Central African Republic.
* Data as of March 25, 2014.
† Regional NPAFP rates use United Nations Development Programme populations as denominators, and therefore tend to be higher than country rates, which use their summed subnational populations as denominators. Regional data available at http://apps.who.int/immunization_monitoring/en/diseases/poliomyelitis/case_count.cfm.
§ Per 100,000 persons aged <15 years.
¶ Standard WHO target is adequate stool specimen collection from ≥80% of AFP cases, in which two specimens are collected within 14 days of paralysis onset ≥24 hours apart, shipped on ice or frozen ice packs and arriving in good condition in a WHO-accredited laboratory. Stool specimen adequacy proportions from regions do not include the criteria of good specimen condition or time between specimens.
** For all subnational areas regardless of the population size.
†† Data at WHO as of April 1, 2014.
§§ Data at WHO as of April 1, 2014; cVDPV are VDPV associated with two or more cases of AFP.

During 2012, genomic sequencing identified two WPV1 genotypes and one WPV type 3 genotype in samples from AFR countries: type 1 West Africa-B1 (WEAF-B1) genotype was detected in Nigeria, Niger, and Chad; type 1 WEAF-B2 type 1 genotype and type 3 WEAF-B genotype were detected only in Nigeria. In the WHO Eastern Mediterranean Region, type 1 South Asia (SOAS) and type 3 SOAS genotypes were detected in 2012. In 2013, only type 1 WEAF-B1 and SOAS genotypes were isolated. When genomic sequencing of an isolate detects ≥1.5% nucleotide divergence in the VP1-coding region from previously identified PV isolates, this highlights prolonged undetected circulation and quality gaps in field AFP surveillance, even though it is not always obvious to determine where transmission was missed. Sequence analysis indicated that WPV cases were likely being missed by AFP surveillance during 2012–2013 in Afghanistan, Cameroon, Chad, Niger, Nigeria, Pakistan, and Syria; cVDPV cases during 2012–2013 were also likely missed in Afghanistan, Nigeria, and Somalia.

TABLE 2. Number of poliovirus (PV) isolates from stool specimens of persons with acute flaccid paralysis and timing of results, by World Health Organization (WHO) region, 2012 and 2013*

	2012							2013						
		No. of PV isolates							No. of PV isolates					
WHO region	No. of specimens	Wild	Sabin†	cVDPV§	PV isolation results on time¶ (%)	ITD results within 7 days** (%)	ITD results within 60 days†† (%)	No. of specimens	Wild	Sabin†	cVDPV§	PV isolation results on time¶ (%)	ITD results within 7 days** (%)	ITD results within 60 days†† (%)
African	39,710	221	2,629	43	(95)	(99)	(93)	42,316	598	2,861	12	(92)	(88)	(84)
Americas	1,926	0	31	0	(77)	(91)	(100)	1,672	0	33	0	(80)	(95)	(91)
Eastern Mediterranean	26,626	174	930	71	(94)	(99)	(99)	20,783	125	626	53	(99)	(98)	(97)
European	3,167	0	66	2	(96)	(75)	(88)	3,404	0	37	0	(99)	(93)	(86)
South-East Asia	129,106	0	3,470	1	(98)	(87)	(100)	116,179	0	3,274	0	(98)	(91)	(98)
Western Pacific	15,094	0	223	8	(98)	(93)	(84)	13,304	0	241	0	(65)	(100)	(99)
Total	215,629	395	7,349	125	(93)	(91)	(94)	197,658	723	7,072	65	(89)	(94)	(93)

Abbreviations: cVDPV = circulating vaccine-derived poliovirus; ITD = intratypic differentiation.

* Data as of April 1, 2014.

† Either concordant Sabin-like results in ITD test and VDPV screening, or <1% sequence difference compared with Sabin vaccine virus (<0.6% for type 2).

§ For PV types 1 and 3, 10 or more VP1 nucleotide differences from the respective PV; for PV type 2, six or more VP1 nucleotide differences from Sabin type 2 PV.

¶ Results reported within 14 days for laboratories in the following WHO regions: African, Americas, Eastern Mediterranean, South-East Asia, and Western Pacific (28 days for China in 2012; change in procedures in China implemented during 2013 and 14 day criterion applied in 2013). Results reported within 28 days for the European Region.

** Results of ITD reported within 7 days of receipt of specimen.

†† Results reported within 60 days of paralysis onset for all WHO regions except Eastern Mediterranean Region, which reported within 45 days of paralysis onset.

Discussion

During 2012–2013, 12 AFR and EMR countries were affected by WPV or cVDPV cases. National and subnational AFP performance indicators highlighted weak performance in seven of these 12 countries. Virologic analysis and environmental surveillance indicated weaknesses in three of the other countries even when AFP indicators were met. These surveillance weaknesses have limited the ability to rapidly detect WPV introductions and better target GPEI immunization activities in areas with transmission.

AFP surveillance indicators remained strong or improved during 2012–2013 in some African countries where WPV or cVDPV outbreaks occurred in the past, including Benin, Côte d'Ivoire, Liberia, Mali, Mauritania, Mozambique, Nigeria, Republic of the Congo, Sierra Leone, South Sudan, and Togo. However, indicators showing surveillance weaknesses were reported in countries with recent circulation within or near the country, including Cameroon, Central African Republic, Ethiopia, Gabon, Kenya, and Niger (as well as Guinea and Senegal), where deficiencies were primarily related to relatively low proportions of AFP cases with adequate specimens. The outbreaks in the Horn of Africa and Central Africa potentially could have been controlled more promptly if they had been detected earlier by surveillance meeting all performance standards; the risk remains for delayed detection of spread to some neighboring countries. The proportion of adequate specimens can be increased in AFP surveillance by careful review of the reasons for late detection or investigation, refresher training of surveillance and investigative staff, and enhanced field supervision. AFP surveillance indicators were generally strong in polio-affected countries in EMR, with the exception of Syria, where surveillance efforts are limited by civil conflict and displacement of populations.

The occurrence of WPV outbreaks in previously polio-free countries in Africa and the Middle East is a reminder that all countries remain at risk as long as WPV continues to circulate in any one country. For prompt detection of WPV introduction and for ultimate certification of polio eradication, polio-free countries should maintain certification-standard surveillance performance indicators. The *GPEI Polio Eradication and Endgame Strategic Plan for 2013–2018* (*9*) prioritizes efforts to maintain and improve PV surveillance at all administrative levels throughout each country, including active AFP surveillance at health facilities, with special attention to populations with a high risk for undetected PV transmission (e.g., mobile and displaced populations). In countries with large populations (e.g., DRC, Nigeria, and Pakistan), surveillance performance needs to be monitored closely at lower administrative levels (e.g., districts, rather than at states/provinces). Environmental surveillance continues to augment AFP surveillance and will be expanded within selected high-risk countries and those in which WPV is endemic. Intensive efforts to strengthen and maintain AFP surveillance are needed in all countries with current or recent active PV transmission to better target GPEI immunization activities in 2014.

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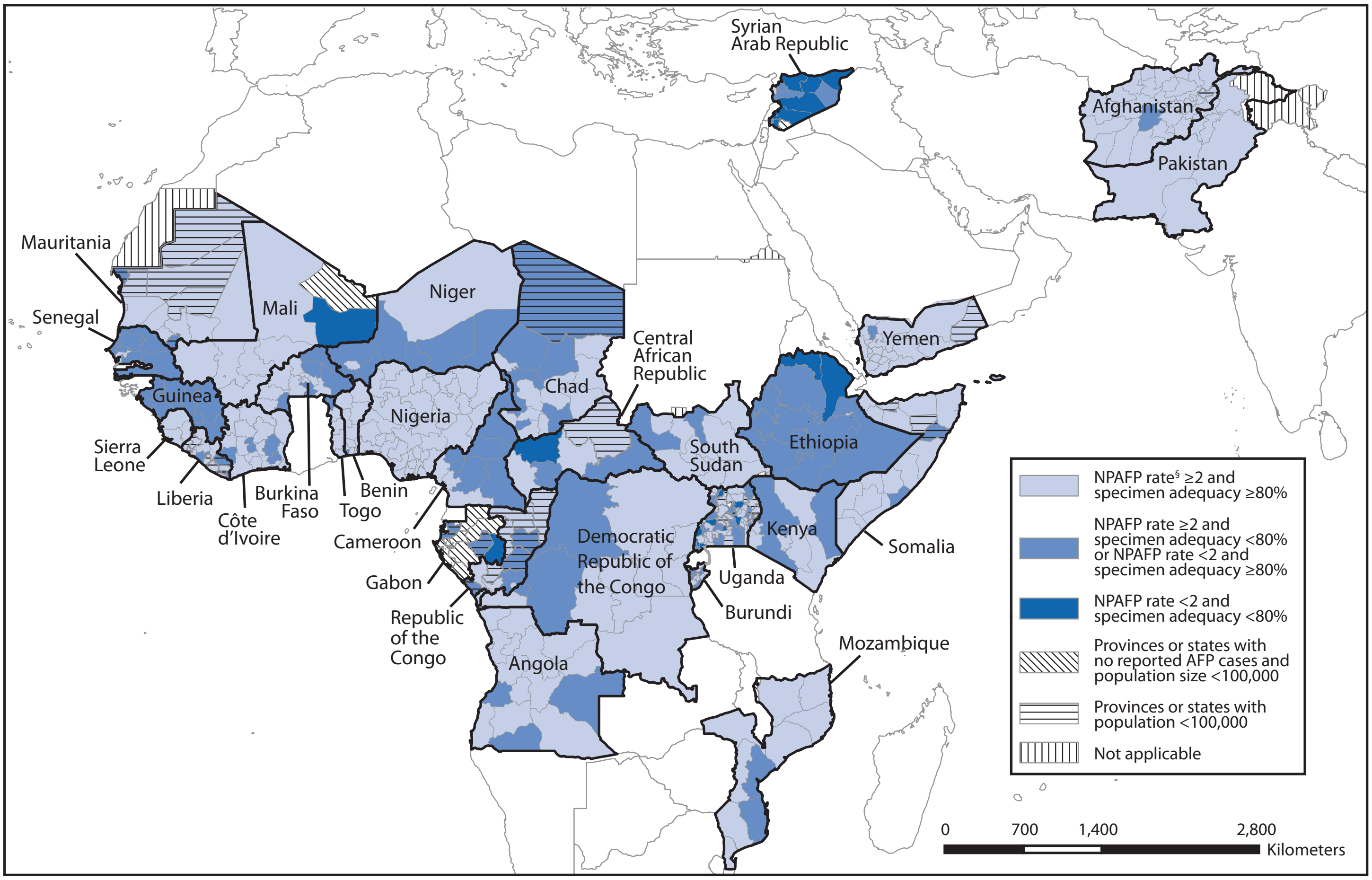
FIGURE. Combined performance indicators for the quality of acute flaccid paralysis (AFP) surveillance* in subnational areas (states and provinces) of 30 countries that were polio-affected during 2009–2013 — World Health Organization African and Eastern Mediterranean regions, 2013†



Abbreviation: NPAFP = nonpolio AFP.

* The Global Polio Eradication Initiative has set the following targets for countries with current or recent wild poliovirus transmission and their states/provinces: 1) NPAFP detection rate of two or more cases per 100,000 persons aged <15 years, and 2) adequate stool specimen collection from ≥80% of AFP cases, with specimen adequacy defined as two specimens collected ≥24 hours apart, both within 14 days of paralysis onset, shipped on ice or frozen packs, and arriving in good condition (without leakage or desiccation) at a World Health Organization–accredited laboratory.

† Data are for AFP cases with onset during 2013, reported as of March 31, 2014.

§ Per 100,000 persons aged >15 years.

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Notes from the Field

Measles — California, January 1–April 18, 2014

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Measles is a highly contagious, acute viral illness that can lead to severe complications and death. Even patients who experience uncomplicated acute measles have a small risk for developing a devastating neurologic illness, subacute sclerosing panencephalitis, years after their infection. Measles was documented as eliminated (defined as interruption of continuous transmission lasting ≥12 months) in the United States in 2000 (*1*); however, importation of measles cases and limited local transmission continue to occur. During January 1–April 18, 2014, the California Department of Public Health received reports of 58 confirmed measles cases, the highest number reported for that period since 1995. Patients ranged in age from 5 months to 60 years. Three (5%) patients were aged <12 months, six (10%) were aged 1–4 years, 17 (29%) were aged 5–19 years, and 32 (55%) were aged ≥20 years. As of April 18, there had been 12 hospitalizations, and no deaths had been reported. During 2000–2013, the median annual number of measles cases reported in California was nine (range = four to 40).

Among the 58 cases, 54 (93%) were classified as importation-associated, including 13 importations, 13 cases epidemiologically linked to importations, 18 with virologic evidence suggesting recent importation, and 10 linked to cases with virologic evidence of recent importation.* The 13 importations were in U.S. residents who had returned from travel to the Philippines (eight), India (two), Singapore (one), Vietnam (one), and Western Europe (one). In contrast, in 2013, eight imported measles cases were reported in California, and none were from the Philippines. Forty-seven of the 58 cases were associated with 12 measles clusters (defined as two or more cases linked in time or place), which included nine outbreaks (defined as three or more cases linked in time or place). Transmission for 11 cases occurred in health-care settings; six of these 11 cases were in health-care personnel. Other transmission settings included households, a church day care center, an airplane, and a school.

Fifty-two of the 58 cases were confirmed by laboratory testing (44 by polymerase chain reaction and eight by immunoglobulin M), and six were confirmed by epidemiologic link to a laboratory-confirmed case. Genotypes identified were B3 (32 patients), the measles genotype currently circulating in the Philippines, and D8 (seven patients) (*2,3*). Five of the seven patients with D8 genotype reported international travel; the remaining two patients with D8 genotype were epidemiologically linked to the imported cases. Genotyping is pending for two of the four cases with unknown source of infection.

Most of the 58 patients were either unvaccinated (25 [43%]) or had no vaccination documentation available (18 [31%]). Of the 25 patients who were known to be unvaccinated, 19 (76%) had philosophical objections to vaccination, three (12%) were too young (aged ≤12 months) for routine vaccination, and three (12%) were unvaccinated for unknown reasons. Eleven (19%) patients had documentation of 2 or more valid doses of measles, mumps, and rubella (MMR) vaccine, including two children and nine adults. Three health-care personnel had documentation of serologic evidence of immunity before exposure, and one additional patient was found to have serologic evidence of immunity when tested as part of a contact investigation before symptom onset.

All persons who were exposed during travel were old enough to have received vaccination before travel (infants traveling to areas with endemic measles can be vaccinated at age 6–11 months). Five of the six unvaccinated travelers were unvaccinated because of philosophical objections; among these, one was not eligible to receive MMR vaccine at the time of travel because of pregnancy (*4*). Six adults had no vaccine documentation available, and one had received 2 valid doses.

In the United States, during January 1–April 18, 2014, a total of 129 cases of measles were reported, the highest number reported for this period since 1996. Among the cases were 34 importations, including 17 in travelers to and from the Philippines. The Philippines has been experiencing an explosive outbreak of measles, with approximately 20,000 confirmed or suspected cases reported during January 1–February 28 and 69 confirmed deaths (*3*). The increase in importations from this outbreak and subsequent transmission in certain settings in the United States highlights the importance of ensuring age-appropriate vaccination for persons traveling to areas where measles is endemic and maintaining high vaccination coverage at the national and local level.

All U.S. residents born after 1956 should ensure that they have received MMR vaccine or have serologic evidence of measles immunity. Vaccine recommendations for travel outside of North or South America by those born after 1956 who do not have serologic evidence of immunity include the following: 1 dose of MMR vaccine for infants aged 6–11 months and 2 doses of MMR separated by at least 28 days for children aged ≥12 months and adults (*4,5*). Prompt identification of patients with suspected measles and implementation of appropriate infection control can reduce transmission in health-care settings (*6*).

* Additional information available at http://wwwn.cdc.gov/nndss/script/casedef.aspx?condyrid=908&datepub=1/1/2013%2012:00:00%20am.

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Anthony Moore, Chris Preas, Wanda Wong, Carlos Gonzalez, Giorgio Cosentino, Abiy Tadesse, Regina Chase, Ashraf Fadol, Lawrence Penning, Chris Anderson, Pat Stoll, MD, Kristina Hsieh, DrPH, Alex Espinosa, Natasha Espinosa, David Cottam, Viral and Rickettsial Disease Laboratory; Annie Luu, Rosie Glenn-Finer, Darryl Kong, MPH, Anna Clayton, MPH, Immunization Branch, California Department of Public Health. Local health departments, California.

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Announcements

National Campaign to Prevent Falls in Construction — United States, 2014

In 2010, the 9.1 million U.S. construction workers (including self-employed workers) accounted for 7% of the national workforce (*1*). According to data from 2011, the rate of fatal injuries in construction was the second highest of any U.S. industry (*2*). Deaths and injuries from falls represent a critical, persistent, yet preventable public health problem. In fact, falls on construction sites are the leading cause of death in the industry (36% in private industry in 2012) (*3*). Many construction occupations require working in high places and climbing ladders or scaffolds on a daily basis. Many workers in construction trades are required to work from heights almost every day. Nearly 60% of workers in construction production occupations work at heights at least once a month, and many stand or climb on ladders or scaffolds during half of their work time (*4*). Safe construction requires skilled workers and responsible employers. The leading fatal events in construction are falls related to roofs, scaffolds, and ladders (*1*).

CDC's National Institute for Occupational Safety and Health (NIOSH) has engaged construction sector stakeholders through a government-labor-management partnership representing state and federal government agencies, professional organizations, trade associations, labor organizations, and private industry to develop a national campaign aimed at construction contractors, onsite supervisors, and workers to address and reduce falls, fall-related injuries, and fall-related fatalities among construction workers. On Workers' Memorial Day, April 28, the Occupational Safety and Health Administration and its stakeholders, including NIOSH, will formally announce its sponsorship of a National Safety Stand-Down to Prevent Falls in Construction during June 2–6. Additional information is available at http://www.osha.gov/stopfallsstanddown.

The Stand-Down is a voluntary event for construction-related employers to speak directly to employees about fall hazards and to reinforce the importance of fall prevention requirements. Modeled on U.S. military programs, the Stand-Down is a part of the national information and media construction falls prevention campaign developed through this partnership. Program sponsors encourage broad engagement and promotion across the United States, including by state agencies and public health practitioners.

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National Infant Immunization Week

From April 26 through May 3, National Infant Immunization Week (NIIW) will focus attention on the role immunization plays in protecting infants from vaccine-preventable diseases. This year marks the 20th anniversary of both NIIW and the Vaccines for Children (VFC) program,* which provides vaccines at no cost for children who might otherwise not be vaccinated because of their caregiver's inability to pay.

NIIW and VFC were initially created in response to a measles epidemic in which thousands of persons became infected as a result of low vaccination coverage among children aged <2 years (*1*). Since 1994, hundreds of communities across the country have joined to promote NIIW. Although immunization coverage among children has increased, recent outbreaks of measles and mumps in the United States underscore the importance of maintaining high immunization rates.

Throughout NIIW, local and state health departments, national immunization partners, and health-care professionals will conduct parent-focused events, clinician education activities, and other events to highlight the positive impact of vaccination on the lives of infants and to call attention to immunization achievements. To support these efforts, a variety of promotional and educational materials are available from CDC on the NIIW website (http://www.cdc.gov/vaccines/events/niiw/index.html).

NIIW is being observed simultaneously with World Immunization Week† (April 24–30), an initiative of the World Health Organization to promote and advance equity in the use of vaccines. Additionally, the winner of the annual CDC Childhood Immunization Champion Award, which recognizes local contributions to public health through work in childhood immunizations, will be announced.

* Additional information available at http://www.cdc.gov/vaccines/programs/vfc/index.html.

† Additional information available at at http://www.who.int/campaigns/immunization-week/2014/en.

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Announcements

World Malaria Day — April 25, 2014

World Malaria Day is commemorated on April 25, the date in 2000 when 44 African leaders met in Abuja, Nigeria, and committed their countries to reducing malaria-related deaths. Between 2000 and 2012, the scale-up of effective malaria prevention and control interventions saved more than 3.3 million lives and decreased malaria mortality by 45% globally and 49% in sub-Saharan Africa. In spite of those accomplishments, an estimated 207 million cases of malaria occurred globally in 2012, resulting in an estimated 627,000 deaths. Because of increases in insecticide and drug resistance and changes in malaria epidemiology as a result of scaled-up interventions, new approaches are needed to sustain progress in malaria control and lead toward elimination. World Malaria Day 2014's theme, "Invest in the Future: Defeat Malaria," is a reminder of the challenge and the ultimate goal.

CDC supports global malaria control efforts through the President's Malaria Initiative, a U.S. government interagency initiative to reduce malaria incidence and mortality in 19 countries in sub-Saharan Africa and in the Greater Mekong Subregion in Asia. This effort has helped deliver millions of insecticide-treated mosquito nets, antimalarial drugs, and rapid diagnostic test kits to ensure that persons at risk for malaria will have access to life-saving prevention and treatment. CDC also conducts multidisciplinary strategic and applied research globally to increase knowledge about malaria and develop safe, effective interventions that can lead to the elimination and eventual eradication of malaria. Additional information regarding CDC's malaria activities is available at http://www.cdc.gov/malaria.

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Air Quality Awareness Week and Asthma Awareness Month — May 2014

CDC is collaborating with the U.S. Environmental Protection Agency to urge U.S. residents to pay attention to their local air quality during Air Quality Awareness Week, April 28–May 2, 2014. May also is Asthma Awareness Month, and May 6 is World Asthma Day.

Asthma sufferers are particularly affected by air pollution. One in 12 U.S. residents (approximately 25.5 million persons) currently has asthma, and nine persons in the United States die from asthma-related complications every day (*1*). Ozone air pollution, more common in the summer months, can trigger asthma attacks, leading to increased medication use, visits to emergency departments, and hospital admissions. Persons with asthma and other at-risk groups can use daily forecasts of the Air Quality Index to plan exercise and other outdoor activities for times when air pollution is predicted to be low.

Persons with asthma and other chronic lung diseases, such as emphysema and chronic bronchitis, are not the only ones affected by ozone. Children, older adults, and active persons of all ages who exercise or work vigorously outdoors also are at risk. Ozone can irritate the respiratory system, reduce lung function, and inflame and damage the lungs. Over time, ozone exposure can cause permanent lung damage.

Daily air quality forecasts and current conditions for 400 U.S. cities are available at http://www.airnow.gov and through the AirNow mobile app (http://m.epa.gov/apps/airnow.html) and Enviroflash e-mail service (http://www.enviroflash.info).

Information on Air Quality Awareness Week is available at http://epa.gov/airnow/airaware/index.html. Information on Asthma Awareness Month is available at http://www.epa.gov/asthma/awareness.html. Additional information about asthma is available from CDC at http://www.cdc.gov/asthma.

Reference

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Errata

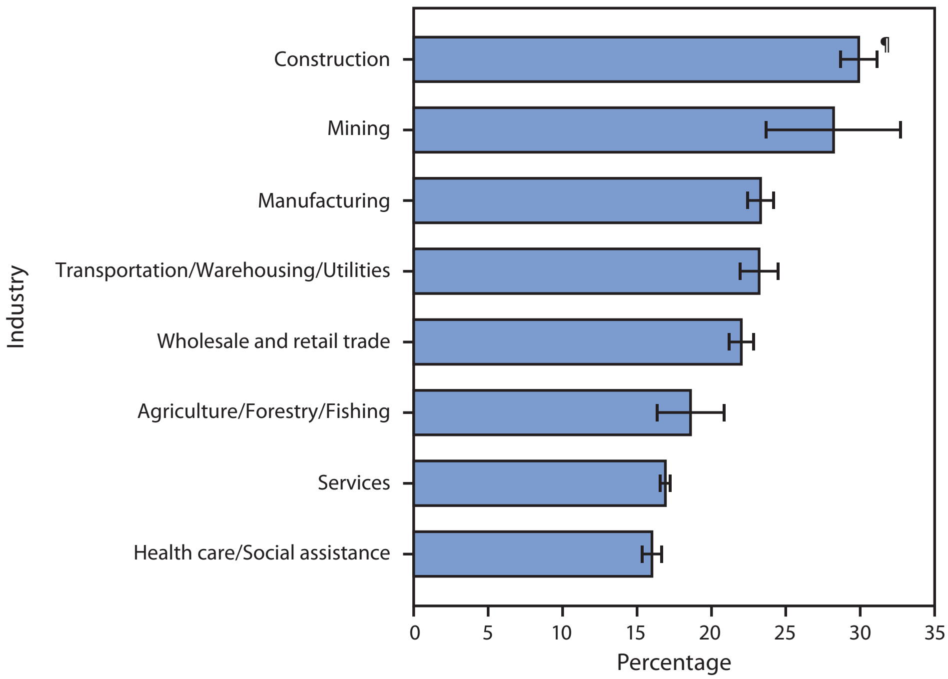
Vol. 63, No. 14

In the report, "Vital Signs: Births to Teens Aged 15–17 Years — United States, 1991–2012," multiple errors occurred. In the Introduction, the first sentence should read, "The U.S. teen birth rate has continued to decline, from **61.8** births per 1,000 teens aged 15–19 years in 1991 to an all-time low of 29.4 in 2012 (*1*)." Three errors occurred in the References. Reference 1 should read, "**Martin JA, Hamilton BE, Osterman JK, Curtin SC, Mathews TJ.** Births: final data for 2012. Natl Vital Stat Rep 2013;62(9)." Reference 8 should read, "Lepkowski J, Mosher W, Groves R, West B, Wagner J, Gu H. Responsive design, weighting, and variance estimation in the 2006–2010 National Survey of Family Growth. Vital Health Stat **2013**;2:2–52." Reference 19 should read, "American Academy of Family Physicians. Adolescents, protecting: ensuring access to care and reporting sexual activity and abuse (position paper). Leawood, KS: American Academy of Family Physicians; **2004**. Available at http://www.aafp.org/about/policies/all/adolescent-protecting.html."

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage of Currently Employed Adults Who Were Current Smokers,* by Selected Industries† — National Health Interview Survey, United States, 2008–2012§



* Based on responses to a question that asked, "Have you smoked at least 100 cigarettes in your entire life?" Respondents answering "yes" were then asked, "Do you now smoke cigarettes every day, some days, or not at all?" Current smokers have smoked at least 100 cigarettes in their lifetime and currently smoke every day or some days.

† Industries include the eight sectors emphasized in the National Occupational Research Agenda (http://www.cdc.gov/niosh/nora/sector.html). In the chart above, "Mining" includes oil and gas extraction, and "Services" includes public safety.

§ Estimates are based on household interviews of a sample of the U.S. civilian, noninstitutionalized population. Adults who were not currently employed at the time of interview and unknowns with respect to smoking and industry were not included in the denominators when calculating percentages.

¶ 95% confidence interval.

During 2008–2012, 29.9% of adults aged ≥18 years currently employed in construction and 28.2% of those currently employed in mining were current smokers. Adults currently employed in construction were more likely than adults currently employed in manufacturing (23.3%), transportation/warehousing/utilities (23.2%), trade (22.0%), agriculture/forestry/fishing (18.6%), services (16.9%), or health care/social assistance (16.0%) to be current smokers.

Sources: National Health Interview Survey, 2008–2012. Available at http://www.cdc.gov/nchs/nhis.htm.

Reported by: Debra L. Blackwell, PhD, debra.blackwell@cdc.hhs.gov, 301-458-4103.

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Data presented by the Notifiable Disease Data Team and 122 Cities Mortality Data Team in the weekly *MMWR* are provisional, based on weekly reports to CDC by state health departments. Address all inquiries about the *MMWR* Series, including material to be considered for publication, to Editor, *MMWR* Series, Mailstop E-90, CDC, 1600 Clifton Rd., N.E., Atlanta, GA 30329-4027 or to *mmwrq@cdc.gov.*

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