Please note: Notice to Readers "Ongoing Reanalysis of Suicide Rates Data by Occupational Group from Results Reported in *MMWR*" has been published for this report. To view, please click here.

Centers for Disease Control and Prevention
MMWR
Morbidity and Mortality Weekly Report
Weekly / Vol. 65 / No. 25
July 1, 2016

Suicide Rates by Occupational Group — 17 States, 2012

Wendy LiKamWa McIntosh, MPH[1]; Erica Spies, PhD[1,2]; Deborah M. Stone, ScD[1]; Colby N. Lokey, MS[1]; Aimée-Rika T. Trudeau, MPH[1]; Brad Bartholow, PhD[1]

In 2012, approximately 40,000 suicides were reported in the United States, making suicide the 10th leading reported cause of death for persons aged ≥16 years (*1*). From 2000 to 2012, rates of suicide among persons in this age group increased 21.1%, from 13.3 per 100,000 to 16.1 (*1*). To inform suicide prevention efforts, CDC analyzed suicide by occupational group, by ascribing occupational codes to 12,312 suicides in 17 states in 2012 from the National Violent Death Reporting System (NVDRS) (*2*). The frequency of suicide in different occupational groups was examined, and rates of suicide were calculated by sex and age group for these categories. Persons working in the farming, fishing, and forestry group had the highest rate of suicide overall (84.5 per 100,000 population) and among males (90.5); the highest rates of suicide among females occurred among those working in protective service occupations (14.1). Overall, the lowest rate of suicide (7.5) was found in the education, training, and library occupational group. Suicide prevention approaches directed toward persons aged ≥16 years that enhance social support, community connectedness, access to preventive services, and the reduction of stigma and barriers to help-seeking are needed.

CDC's National Violent Death Reporting System (NVDRS) collects information on violent deaths, including suicides, from multiple sources, including death certificates, coroner and medical examiner reports, and law enforcement reports, to monitor trends, understand violent death characteristics and risk factors, and inform prevention efforts (*2*). The most recent NVDRS data set available for analysis (2012) includes data from 17 states.*

NVDRS Occupation Title and Industry Title fields were used to assign each suicide decedent to one of the major occupational groups defined by the national Standard Occupational Classification (SOC) system (*3*). The decedent's usual occupation at the time of death was coded, and each decedent was assigned to only one occupational group. Additional codes for decedents who were classified as homemakers/housewives, students, never worked/disabled (and not working), retired, prisoners, unemployed, and self-employed (unspecified industry) were created by the authors.

Decedents were assigned to SOC codes using three steps. First, the National Institute for Occupational Safety and Health's Industry and Occupation Computerized Coding System (NIOCCS) (*4*) was applied to the 12,312 suicides in the data set, resulting in SOC codes for 5,532 (44.9%) decedents (Figure). NIOCCS matched the industry and occupation text fields to U.S. Census Industry and Occupation codes†; these were mapped to detailed SOC codes, which the authors collapsed into major SOC occupational groups. Next, a computer algorithm (developed based on a review of

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

† http://www.census.gov/people/io/.

INSIDE

646 Assessment of Staffing, Services, and Partnerships of Local Health Departments — United States, 2015
650 Blood Lead Levels Among Children Aged <6 Years — Flint, Michigan, 2013–2016
655 Notes from the Field: Four Multistate Outbreaks of Human *Salmonella* Infections Linked to Small Turtle Exposure — United States, 2015
657 Announcement
659 QuickStats

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

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention

cases for which a SOC code was not provided by NIOCCS) was used to produce codes for an additional 4,572 (37.1%) decedents.[§] Finally, manual coding by the authors was used for the remaining 2,208 (17.9%) decedents (Figure). For 729 (5.9%) decedents, the occupation fields were blank or lacked sufficient information; these were coded as "unknown." Interrater reliability was assessed for a random 5% sample (635 decedents) of the data set, with resulting Cohen's kappa coefficient of 0.87 (554 decedents); the remaining 81 decedents not in agreement were resolved through discussions among the authors.

Descriptive data were analyzed, including the number of suicides and rates of suicide by occupational group. Occupational groups were stratified by sex, and rates of suicide were calculated for each group using denominators derived from the U.S. Census Bureau's Current Population Survey March Supplement (*5*), which includes a question about the person's primary occupation during the previous calendar year. Rates were not calculated for occupation codes created by the authors, because the Current Population Survey data set does not provide denominator data for these groups. U.S. child labor laws prohibit persons aged <16 years from working full-time; therefore, only decedents aged ≥16 years were included. SOC code 55 (i.e., military specific occupations) was not included in the analysis because it was not possible to reliably determine whether these decedents were on active duty or retired, or what occupation they held in the military. If a decedent had a specific coded job and was employed by the military, that decedent was coded according to the occupation (e.g., an engineer working for the military would be included in the "Architecture and engineering" occupational group).

Among the 12,312 suicide decedents included in the 2012 data set, 9,509 (77.2%) were male, and 2,801 (22.8%) were female; information about sex was missing for two decedents (Table 1). Decedents ranged in age from 16 to 102 years; however, 84.5% were aged 16–64 years. Nearly one third of all suicides occurred among persons in the following four occupational groups: construction and extraction (1,324; 10.8%); management (1,049; 8.5%); production (953; 7.7%); and installation, maintenance, and repair (780; 6.3%) (Table 1). The highest proportion (22.7%) of suicides occurred among persons aged 45–54 years, and the lowest proportion (11.6%) occurred among persons aged 16–24 years (Table 1).

Rates of suicide were highest in the following three occupational groups: farming, fishing, and forestry (84.5 suicides per 100,000 persons); construction and extraction (53.3); and installation, maintenance, and repair (47.9) (Table 2). Rates of suicide varied by sex, with higher rates among males than females in all occupational groups (Table 2). Among males, the highest suicide rates were among persons in the following three occupational

[§] In cases for which NIOCCS provided a U.S. Census occupation code but did not provide an SOC code, the algorithm recoded the U.S. Census occupation codes to SOC codes and author-created codes. The algorithm also was used to code many of the remaining decedents not assigned a detailed SOC or U.S. Census occupation code by NIOCCS using the industry and occupation text fields. Because the algorithm coded only to SOC major groups, it was able to record more decedents than NIOCCS.

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

Suggested citation: [Author names; first three, then et al., if more than six.] [Report title]. MMWR Morb Mortal Wkly Rep 2016;65:[inclusive page numbers].

Centers for Disease Control and Prevention
Thomas R. Frieden, MD, MPH, *Director*
Harold W. Jaffe, MD, MA, *Associate Director for Science*
Joanne Cono, MD, ScM, *Director, Office of Science Quality*
Chesley L. Richards, MD, MPH, *Deputy Director for Public Health Scientific Services*
Michael F. Iademarco, MD, MPH, *Director, Center for Surveillance, Epidemiology, and Laboratory Services*

***MMWR* Editorial and Production Staff (Weekly)**
Sonja A. Rasmussen, MD, MS, *Editor-in-Chief*
Charlotte K. Kent, PhD, MPH, *Executive Editor*
Jacqueline Gindler, MD, *Editor*
Teresa F. Rutledge, *Managing Editor*
Douglas W. Weatherwax, *Lead Technical Writer-Editor*
Soumya Dunworth, PhD, Teresa M. Hood, MS, *Technical Writer-Editors*
Martha F. Boyd, *Lead Visual Information Specialist*
Maureen A. Leahy, Julia C. Martinroe, Stephen R. Spriggs, Moua Yang, Tong Yang, *Visual Information Specialists*
Quang M. Doan, MBA, Phyllis H. King, Terraye M. Starr, *Information Technology Specialists*

***MMWR* Editorial Board**
Timothy F. Jones, MD, *Chairman*
Matthew L. Boulton, MD, MPH
Virginia A. Caine, MD
Katherine Lyon Daniel, PhD
Jonathan E. Fielding, MD, MPH, MBA
David W. Fleming, MD
William E. Halperin, MD, DrPH, MPH
King K. Holmes, MD, PhD
Robin Ikeda, MD, MPH
Rima F. Khabbaz, MD
Phyllis Meadows, PhD, MSN, RN
Jewel Mullen, MD, MPH, MPA
Jeff Niederdeppe, PhD
Patricia Quinlisk, MD, MPH
Patrick L. Remington, MD, MPH
Carlos Roig, MS, MA
William L. Roper, MD, MPH
William Schaffner, MD

FIGURE. Procedure for assigning National Standard Occupational Classification (SOC) system codes for decedent occupations in suicide cases from CDC's National Violent Death Reporting System (NVDRS) — 17 U.S. states, 2012

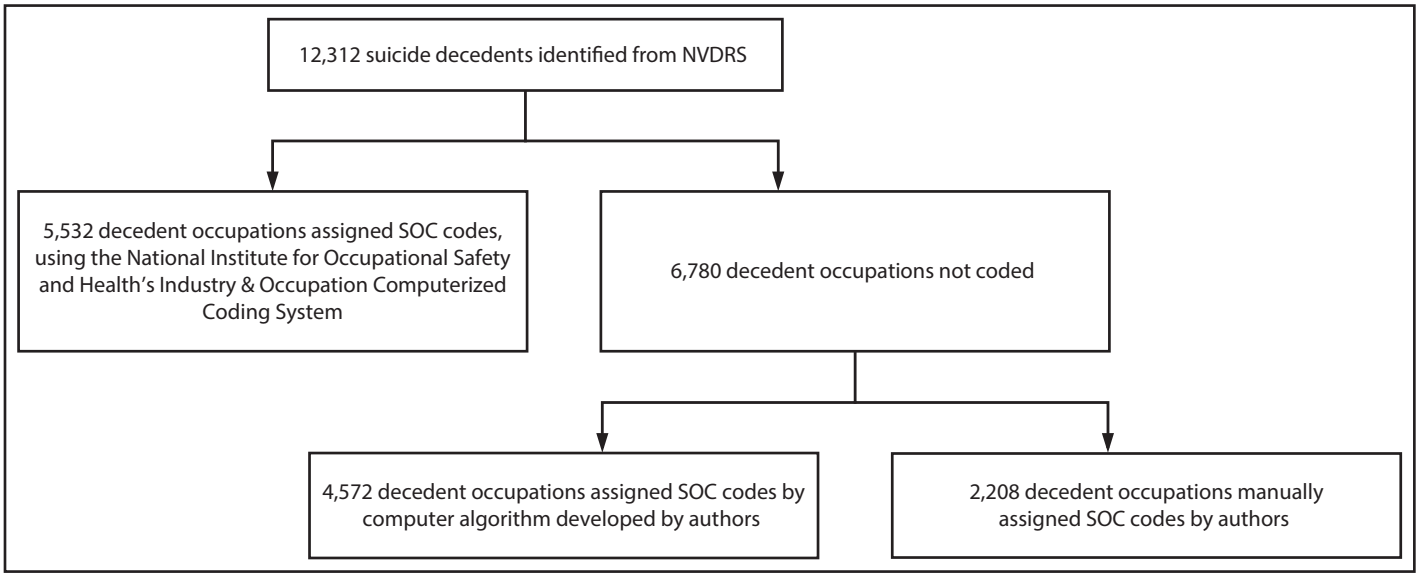


TABLE 1: Number of suicide decedents (N = 12,312) assigned to national Standard Occupational Classification (SOC) groups, by sex and age group — 17 states, 2012

SOC code	Occupational group	Total	Sex*		Age group (yrs)					
		No. (%)	Male	Female	16–24	25–34	35–44	45–54	55–64	≥65
47	Construction and extraction	1,324 (10.8)	1,306	18	85	247	274	329	211	178
11	Management	1,049 (8.5)	881	167	30	120	174	262	229	234
51	Production	953 (7.7)	866	87	80	149	148	205	172	199
49	Installation, maintenance, and repair	780 (6.3)	764	16	50	110	153	233	130	104
99†	Unknown	729 (5.9)	575	153	86	131	114	172	113	113
69†	Student	665 (5.4)	493	172	530	110	19	4	2	0
41	Sales and related	651 (5.3)	520	131	67	82	98	144	123	137
53	Transportation and material moving	644 (5.2)	618	26	35	97	98	154	152	108
59†	Homemaker, Housewife	534 (4.3)	15	519	21	79	107	150	95	82
43	Office and administrative support	481 (3.9)	240	241	43	88	71	115	99	65
29	Healthcare practitioners and technical	450 (3.7)	187	263	9	59	91	110	105	76
79†	Never worked, Disabled	380 (3.1)	273	107	65	68	62	113	59	13
13	Business and financial operations	353 (2.9)	223	130	10	39	65	96	81	62
35	Food preparation and serving related	358 (2.9)	236	122	66	106	64	73	32	17
15	Computer and mathematical	329 (2.7)	280	49	26	54	78	89	48	34
33	Protective service	295 (2.4)	266	29	15	46	61	71	57	45
17	Architecture and engineering	274 (2.2)	263	11	10	21	35	59	55	94
37	Building and grounds cleaning and maintenance	239 (1.9)	206	33	33	57	37	60	35	17
89†	Unemployed	228 (1.9)	178	50	52	46	50	50	26	4
25	Education, training, and library	216 (1.8)	117	99	5	25	30	56	51	49
27	Arts, design, entertainment, sports, and media	216 (1.8)	163	53	18	47	47	40	37	27
45	Farming, fishing, and forestry	206 (1.7)	194	12	22	36	25	35	25	63
88†	Prisoner	179 (1.5)	167	12	34	57	46	29	10	3
31	Health care support	178 (1.4)	51	127	19	36	40	41	36	6
39	Personal care and service	133 (1.1)	68	65	10	27	28	33	20	15
85†	Retired	118 (1.0)	111	7	0	1	0	4	14	99
21	Community and social service	109 (0.9)	65	44	1	24	21	15	32	16
23	Legal	103 (0.8)	64	39	0	7	20	22	32	22
19	Life, physical, and social science	89 (0.7)	75	14	2	15	16	18	21	17
98†	Self-employed (unspecified)	49 (0.4)	44	5	2	7	5	16	6	13
Total		**12,312 (100.0)**	**9,509**	**2,801**	**1,426**	**1,991**	**2,077**	**2,798**	**2,108**	**1,912**
% of total		—	**77.2**	**22.8**	**11.6**	**16.2**	**16.9**	**22.7**	**17.1**	**15.5**

* Information on sex was missing for two decedents.
† Author-assigned SOC codes.

TABLE 2. Rates of suicide per 100,000 population, by sex, and ranked overall by Standard Occupation Classification (SOC) group — 17 states, 2012*

SOC code	Occupational group	Overall	Male	Female
45	Farming, fishing, and forestry	84.5	90.5	—†
47	Construction and extraction	53.3	52.5	—
49	Installation, maintenance, and repair	47.9	47.5	—
51	Production	34.5	39.5	10.8
17	Architecture and engineering	32.2	36.3	—
33	Protective service	30.5	34.1	14.1
27	Arts, design, entertainment, sports, and media	24.3	32.9	12.4
15	Computer and mathematical	23.3	32.8	12.5
53	Transportation and material moving	22.3	30.2	4.8
11	Management	20.3	27.4	8.4
23	Legal	18.8	24.2	13.9
29	Healthcare practitioners and technical	17.4	31.6	13.3
19	Life, physical, and social science	16.7	23.7	—
13	Business and financial operations	15.9	20.4	10.3
31	Health care support	14.6	32.9	11.8
21	Community and social service	13.6	18.6	8.9
41	Sales and related	13.4	21.0	5.3
37	Building and grounds cleaning and maintenance	13.3	16.5	4.5
35	Food preparation and serving related	12.8	19.3	7.7
39	Personal care and service	8.0	17.2	4.9
43	Office and administrative support	7.9	15.2	5.3
25	Education, training, and library	7.5	15.1	4.7
Total		**20.3**	**39.2**	**12.4**

* Rates were calculated using data from the U.S. Census Current Population Survey March supplement.
† Rates were not calculated where the decedents were fewer than 20 because those estimates might be unreliable.

groups: farming, fishing, and forestry (90.5 per 100,000); construction and extraction (52.5); and installation, maintenance, and repair (47.5). Among females, the highest suicide rates occurred among persons in the following three occupational groups: protective service occupations (e.g., law enforcement officers and firefighters) (14.1 per 100,000); legal (13.9); and healthcare practitioners and technical (13.3) (Table 2).

Discussion

Earlier studies of suicide by occupation type in the United States have examined one occupational group at a time, such as police suicides (*6*), or have studied data from a specific U.S. state (*7*). This analysis includes recent data from 17 states and an analysis by sex. The proportions of suicides among males (77.2%) and females (22.8%) in this analysis were similar to those reported nationally in 2012 (78.3% and 21.7%, respectively) (*1*).

Occupational groups with higher suicide rates might be at risk for a number of reasons, including job-related isolation and demands, stressful work environments, and work-home imbalance, as well as socioeconomic inequities, including lower income, lower education level, and lack of access to health services (*7*,*8*). Previous research suggests that farmers' chronic exposure to pesticides might affect the neurologic system and contribute to depressive symptoms. Other factors that might contribute to suicide among farmers include social isolation, potential for financial losses, barriers to and unwillingness to seek mental health services (which might be limited in rural areas), and access to lethal means (*8*). Construction workers might be at higher risk because of financial and interpersonal concerns related to lack of steady employment, and fragmented community or isolation (*9*). It has been hypothesized that one possible factor contributing to higher suicide risk among workers in installation, maintenance, and repair occupations might be long-term exposure to solvents that can cause neurotoxic damage, including memory impairment and depressive symptoms (*8*). Research has suggested that higher suicide rates among police are related to stressors including exposure to traumatic, violent, and lethal situations; work overload; shift work; and access to lethal means (*6*,*8*). Females in protective service occupations might also experience additional stressors in these traditionally male-dominated occupations (*6*). Of note, while management occupations had the 10th highest rate of suicide, they accounted for the second largest percentage of suicide deaths overall; therefore, it is important to target prevention strategies to managers as well.

The findings in this report are subject to at least four limitations. First, for 729 (5.9%) cases, an occupation or workforce status could not be determined. Second, using an automated system such as NIOCCS, a computer algorithm, and human coders to assign occupation codes might introduce errors in categorizing industry and occupation; however, interrater reliability checks suggested a high level of consistency. Third, coding of industry and occupation in NVDRS, which uses open-ended fields, depends on the completeness of information available from the NVDRS data sources and accuracy of information provided by informants to these systems (e.g., coroner/medical examiner and family members). Variations in coding might occur depending on the abstractor's amount of experience. For this reason, CDC provides abstractor training, and states conduct blinded re-abstraction of cases to test consistency and identify training needs. Industry and occupation categories assigned in NVDRS are a decedent's "usual occupation," which might not reflect the decedent's actual position or positions at the time of death. Finally, the 17 NVDRS states examined in this report are not nationally representative. Analyses of forthcoming data from the expansion of NVDRS into 32 states in 2014 might provide more representative findings, and permit examination of occupational trends over time.

Suicide prevention activities directed toward persons aged ≥16 years include enhancing connectedness to family and friends, encouraging help-seeking for persons exhibiting signs of distress or suicidality, and supporting efforts to reduce stigma associated with help-seeking and mental illness. Some potential

Summary

What is already known about this topic?

In 2012, suicide was the 10th leading cause of death among persons aged ≥16 years in the United States, with approximately 40,000 suicide deaths reported among persons aged ≥16 years. From 2000 to 2012, rates of suicide for persons aged ≥16 years increased 21.1%, from 13.3 per 100,000 to 16.1. Understanding suicides by occupational group provides an opportunity for prevention, but such data have not been reported recently for a broad population or examined by sex and occupation classification.

What is added by this report?

Analysis of 2012 National Violent Death Reporting System data from 17 states indicated that workers in the farming, fishing, and forestry occupational group had the highest rate of suicide (84.5 per 100,000), followed by workers in construction and extraction (53.3), and installation, maintenance, and repair (47.9). Among males, farming, fishing, and forestry also accounted for the highest rates of suicide (90.5 per 100,000), whereas the highest rate among females (14.1) was among workers in the protective service occupational group.

What are the implications for public health practice?

Suicide prevention activities directed toward persons aged ≥16 years, particularly male workers in farming, fishing, and forestry occupations and female workers in protective services are needed. Prevention strategies that enhance social support, community connectedness, access to preventive services, and reduction of stigma and barriers to help-seeking are encouraged.

suicide prevention strategies include workplace approaches, such as employee assistance programs, which might serve as gateways to behavioral health treatment. Workplace wellness programs can provide education and training for staff members and supervisors to aid in recognition of suicide warning signs (e.g., withdrawal, increased substance abuse, agitation, and putting affairs in order). Employers also can use technology to provide online mental health screenings, web-based tools for mental health information, and mental health screening kiosks for their employees, as well as ensure that employees are aware of the National Suicide Prevention Lifeline (http://www.suicidepreventionlifeline.org; 1-800-273-8255).

The National Action Alliance for Suicide Prevention (NAASP) Workplace Task Force has developed a Comprehensive Blueprint for Workplace Suicide Prevention that addresses suicide prevention strategies, such as screening, mental health services and resources, suicide prevention training, life skills and social network promotion, and education and advocacy.¶

The NAASP online site has resources targeted specifically to the construction and law enforcement industries. Evidence-based suicide prevention strategies implemented in the workplace have the potential to reduce the number of suicides among all occupational groups.

Acknowledgments

Curtis Florence, PhD, Feijun Luo, PhD, Division of Analysis, Research, and Practice Integration, National Center for Injury Prevention and Control, CDC.

[1]Division of Violence Prevention, National Center for Injury Prevention and Control, CDC; [2]Epidemic Intelligence Service, CDC.

Corresponding author: Wendy LiKamWa McIntosh, wmcintosh@cdc.gov, 770-488-3975.

References

1. National Center for Injury Prevention and Control. Web-based Injury Statistics Query and Reporting System (WISQARS). Atlanta, GA: US Department of Health and Human Services, CDC, National Center for Injury Prevention and Control; 2015. http://www.cdc.gov/injury/wisqars
2. Paulozzi LJ, Mercy J, Frazier L Jr, Annest JL. CDC's National Violent Death Reporting System: background and methodology. Inj Prev 2004;10:47–52. http://dx.doi.org/10.1136/ip.2003.003434
3. US Bureau of Labor Statistics. Occupational employment statistics. Washington, DC: US Bureau of Labor Statistics; 2015. http://www.bls.gov/oes/current/oes_stru.htm
4. National Institute for Occupational Safety and Health. NIOSH Industry and Occupation Computerized Coding System (NIOCCS). Atlanta, GA: US Department of Health and Human Services, CDC, National Institute for Occupational Safety and Health; 2014. https://wwwn.cdc.gov/niosh-nioccs/Default.aspx
5. US Census Bureau. Current population survey: 2013 March supplement. Washington, DC: US Census Bureau; 2015. http://thedataweb.rm.census.gov/ftp/cps_ftp.html
6. Loo R. A meta-analysis of police suicide rates: findings and issues. Suicide Life Threat Behav 2003;33:313–25.
7. Stallones L, Doenges T, Dik BJ, Valley MA. Occupation and suicide: Colorado, 2004–2006. Am J Ind Med 2013;56:1290–5.
8. Tiesman HM, Konda S, Hartley D, Chaumont Menéndez C, Ridenour M, Hendricks S. Suicide in U.S. workplaces, 2003–2010: a comparison with non-workplace suicides. Am J Prev Med 2015;48:674–82. http://dx.doi.org/10.1016/j.amepre.2014.12.011
9. Carson J Spencer Foundation. A construction industry blueprint: suicide prevention in the workplace. Denver, CO: Carson J Spencer Foundation; 2015. http://actionallianceforsuicideprevention.org/sites/actionallianceforsuicideprevention.org/files/Suicide%20Prevention%20in%20the%20Workplace%20-%20Final.pdf

¶ http://actionallianceforsuicideprevention.org/comprehensive-blueprint-workplace-suicide-prevention-1.

Assessment of Staffing, Services, and Partnerships of Local Health Departments — United States, 2015

Sarah J. Newman, MPH[1]; Jiali Ye, PhD[1]; Carolyn J. Leep, MPH[1]; LaMar Hasbrouck, MD[1]; Carlos Zometa, PhD[2]

Beginning in 2008, the National Association of County and City Health Officials (NACCHO) periodically surveyed local health departments (LHDs) to assess the impact of the economic recession on jobs and budgets (*1*). In 2014, the survey was expanded to assess a wider range of factors affecting programs, services, and infrastructure in LHDs and renamed the Forces of Change survey (*2*). The survey was administered in to January–February 2015 to 948 LHDs across the United States to assess budget changes, job losses, changes in services, and collaboration with health care partners; 690 (73%) LHDs responded. Findings indicated a change in LHD infrastructure: compared with the previous fiscal year.* Overall, LHDs reported 3,400 jobs lost; 25% of LHDs reported budget decreases; 36% reported a reduction in at least one service area; and 35% reported serving fewer patients in clinics. In addition, up to 24% of LHDs reported expanding population-based prevention services, and LHDs reported exploring new collaborations with nonprofit hospitals and primary care providers (PCPs).

The public health and clinical care environment is evolving in part in response to the Patient Protection and Affordable Care Act (ACA). Section 501(r)(3) of the Patient Protection and Affordable Care Act (ACA) requires that nonprofit hospitals conduct and report on a community health needs assessment (CHNA) every 3 years to maintain their tax-exempt status (*3*). The ACA also requires that a CHNA take into account input from stakeholders that represent the broad interests of the community served by the hospital, including those with special knowledge or expertise in public health, such as LHDs. New systems of care with PCPs intended to improve patient outcomes and reduce costs have also been developed in recent years. These include State Innovation Models (state-based, multipayer health care payment and service delivery models), patient-centered medical homes (primary care delivery models that are patient-centered, comprehensive, team-based, accessible, and focused on quality and safety), and accountable care organizations (networks of health care providers voluntarily responsible for providing coordinated care to patients) (*4*).

An online survey was distributed during January–February 2015 to a statistically representative sample of 948 LHDs across all regions of the United States, representing approximately one third of all LHDs. LHDs were stratified by state and size of the population served (small [<50,000 persons], medium [50,000–499,999], and large [>500,000]). Hawaii and Rhode Island were excluded from the study because they have no LHDs. Survey topics were identified by NACCHO's executive leadership, and several partner organizations provided input on the highest-priority topics, which included changes in LHD budgets, staffing, and services provided from the previous year; changes in clinical service delivery; third-party billing for clinical services; collaboration with nonprofit hospitals; and collaboration with PCPs (*5*). A survey instrument with 16 closed-ended questions was developed, reviewed by subject-matter experts, and piloted. Responses were self-reported and were not independently verified by NACCHO. Nationally representative estimates were weighted to account for sampling design and nonresponse. Information about the survey methods is available in the survey's technical documentation (*6*).

The survey was completed by 690 (73%) top executives from 353 small, 271 medium, and 66 large LHDs. All surveyed areas except the District of Columbia and Massachusetts achieved a response rate of ≥50% (*6*). Overall, 23% of LHDs reported a lower budget in the current fiscal year compared with the preceding fiscal year, and 27% reported that they expected budget decreases to continue into the next fiscal year (Table). LHDs reported 3,400 jobs lost during 2014 (1,300 [38%] because of layoffs and 2,100 [62%] because of attrition). Since 2008, a total of 51,700 jobs have been lost. The number of lost jobs in 2014 was most marked among large LHDs: 61% of large LHDs reported at least one job lost, followed by 41% of medium LHDs and 26% of small LHDs. Approximately one third (36%) of LHDs reported reduced services in at least one program area during 2014. More LHDs reported reducing rather than expanding clinical services such as immunization (14% reducing versus 12% expanding), diabetes screening (14% versus 11%), or high blood pressure screening (11% versus 8%).

Approximately one third (35%) of LHDs reported serving fewer patients in their clinics during 2014 than 2013 (Table); this varied by state (Figure 1). However, a larger proportion of LHDs reported expanding population-based prevention services: 24% of LHDs expanded obesity prevention services, and 23% reported expanding tobacco, alcohol, and other drug prevention services.

*Fiscal years vary across LHDs in the United States.

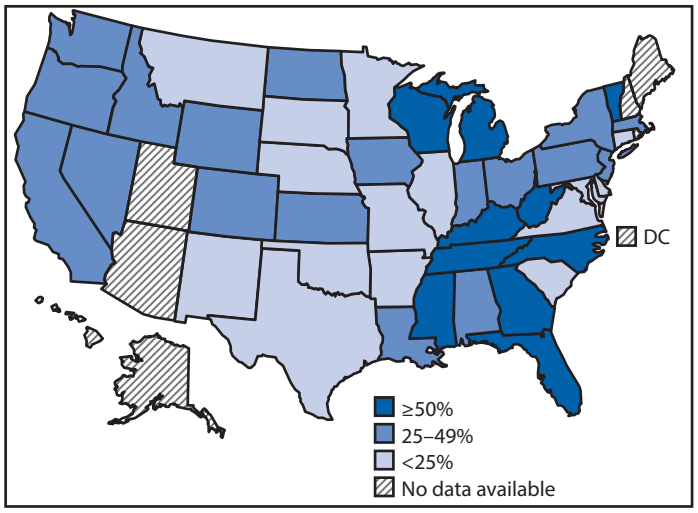
TABLE. Number and percentage of 690 local health departments (LHDs) reporting recent budget changes, job losses, changes in services, third party billing practices, and collaboration with nonprofit hospitals and primary care providers, by size of population served — National Association of County and City Health Officials Forces of Change survey, United States,* 2015

Factor	No. of LHDs responding†	Unweighted no.	Size§ of population served by LHD (%)			
			All	Small	Medium	Large
Budget changes						
Lower budget than the previous fiscal year	666	151	23	22	23	25
Expect lower budget in the next fiscal year	632	171	27	25	28	33
Higher budget than the previous fiscal year	666	143	21	17	28	16
Expect higher budget in the next fiscal year	632	109	17	15	20	19
Job losses in 2014						
Lost at least one job because of layoffs and/or attrition	657	227	34	26	41	61
Changes in services provided in 2014						
Reduced services in at least one program area	679	251	36	35	38	38
Expanded services in at least one program area	679	361	53	48	59	58
Reduced immunization services	657	98	14	14	14	21
Expanded immunization services	657	82	12	14	12	4
Reduced diabetes screening services	255	37	14	14	15	15
Expanded diabetes screening services	255	31	11	6	18	23
Reduced high blood pressure screening services	412	44	11	10	12	15
Expanded high blood pressure screening services	412	36	8	6	14	1
Reduced obesity prevention services	458	35	7	9	7	6
Expanded obesity prevention services	458	110	24	17	31	28
Reduced tobacco, alcohol, and other drug prevention services	514	46	9	11	6	11
Expanded tobacco, alcohol, and other drug prevention services	514	118	23	20	27	23
Changes in clinical service delivery in 2014 compared with 2013						
Served fewer patients	626	221	35	34	37	33
Served the same number of patients	626	269	43	44	40	44
Served more patients	626	136	22	21	23	24
Served fewer patients with insurance	662	46	7	7	7	6
Served the same number of patients with insurance	662	186	28	29	29	25
Served more patients with insurance	662	258	38	37	39	45
Current third-party billing for clinical services						
Bill public payers only	610	149	23	21	24	38
Bill public and private payers	610	428	66	66	69	53
Bill private payers only	610	3	0.5	1	0	2
Do not bill	610	63	10	12	8	7
Collaboration with nonprofit hospitals on community health needs assessments						
Currently collaborating	621	367	58	49	67	67
Discussing collaboration	621	59	9	8	8	24
Not engaged in discussion or collaboration	621	72	12	13	11	9
Involvement in nonprofit hospital implementation plans						
Involved in nonprofit hospital implementation plan	515	313	60	58	61	60
Listed as partner in implementation plan	402	402	47	43	49	52
Participated in developing the implementation plan	402	168	41	41	43	29
Listed as conducting an activity in the implementation plan	402	402	20	16	24	21
Used the same implementation plan	402	39	10	9	11	5
Active collaboration with primary care providers (PCPs)						
Encouraged PCPs to use evidence-based public health services	663	411	61	58	63	76
Provided population health statistics to PCPs	661	316	47	39	54	59
Used clinical data from PCPs	643	148	23	21	23	32
Participated in State Innovation Model initiative activities	659	66	9	4	14	23
Participated in patient-centered medical home activities	658	63	9	6	12	19
Participated in accountable care organizations	657	53	8	7	9	9

* Hawaii and Rhode Island not included.
† Number of LHDs responding is smaller than total number of respondents (n = 690) because of missing values and/or because respondents could skip questions based on their responses to screening questions.
§ Small: serve <50,000 persons (n = 353 LHDs); medium: serve 50,000–499,999 persons (n = 271); large: serve >500,000 persons (n = 66).

During 2014, 38% of LHDs reported serving a higher percentage of insured patients than they had during 2013. Among sampled LHDs in 26 states that expanded Medicaid eligibility in 2015, 46% reported serving a higher percentage of patients with insurance, compared with 29% in states that did not expand Medicaid eligibility. Most LHDs (90%) bill third-party payers (i.e., Medicare, Medicaid, and private insurers) for some services; 66% of LHDs reported they billed both public

FIGURE 1. State* percentage of local health departments serving fewer patients in their clinics in 2014 compared with 2013 — United States



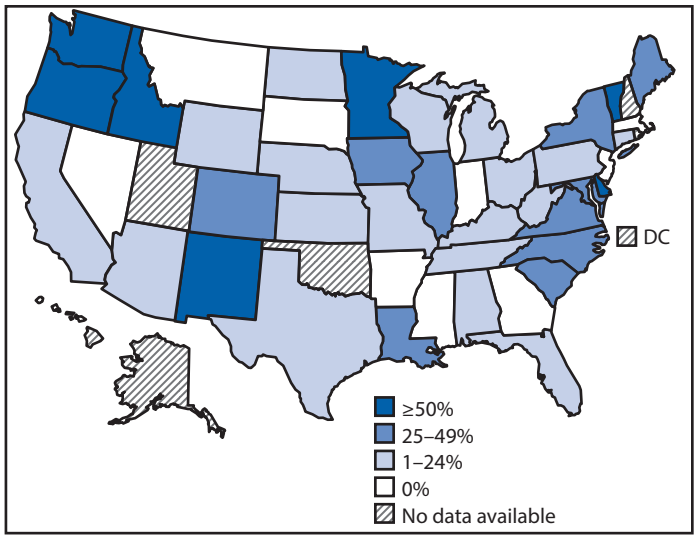
* Hawaii and Rhode Island excluded because they have no local health departments. Data from states with insufficient response rates (Alaska, Arizona, District of Columbia, Maine, New Hampshire, and Utah) not shown.

and private payers for at least some services, and 23% reported they billed public payers only. Respondents reported that the cost and complexity of establishing billing, the existence of a trained workforce, and information technology capacity were most important in determining billing practices.

Approximately half (58%) of LHDs reported that they were currently collaborating with nonprofit hospitals to conduct CHNAs. A smaller percentage (9%) of LHDs were considering future collaboration, and some (12%) were not engaged in discussions to collaborate. The remaining LHDs (21%) did not report having a nonprofit hospital serving their jurisdiction. In addition, among LHDs with a nonprofit hospital serving their jurisdiction, 60% were involved in a nonprofit hospital's implementation plan for the CHNA. Among these, 47% were listed as a partner in the plan, 41% participated in developing the plan, 20% reported that they were conducting an activity in the plan, and 10% of LHDs reported using the same implementation plan as the hospital.

LHDs also reported collaborating with PCPs. Approximately half (61%) of LHDs actively encouraged PCPs to use evidence-based public health services, such as interventions to reduce asthma triggers in children's homes; 47% provided population health statistics to PCPs; and 23% used clinical data from PCPs. Overall, less than 10% of LHDs were actively engaged in new systems of care with PCPs including State Innovation Models, patient-centered medical homes, or accountable care organizations. This engagement also varied across states (Figure 2).

FIGURE 2. State* percentage of local health departments actively engaged with primary care providers on State Innovation Models, accountable care organizations, or patient-centered medical homes — United States, 2014



* Hawaii and Rhode Island excluded because they have no local health departments. Data from states with insufficient response rates (Alaska, District of Columbia, New Hampshire, Oklahoma, and Utah) not shown.

Discussion

The severe United States economic recession (December 2007–June 2009) substantially affected the operating budgets of LHDs. Although the proportion of LHDs reporting budget decreases in the past year has decreased from its peak of 45% in 2009 (*1*), approximately one in four LHDs still reported budget cuts in the current fiscal year compared to the previous fiscal year. Since 2008, LHDs have collectively lost 51,700 jobs because of layoffs and attrition (*1*). For many LHDs, the cumulative effects of budget cuts and job losses experienced during and after the recession have not been reversed as the economy recovered. Consequently, the cumulative effects of years of budget cuts and job losses continue to reduce capacity at many LHDs and decrease the ability of LHDs to prepare for the future.

The ACA's expansion of insurance benefits is reflected in changes in patient volume at LHDs and percentage of patients at LHDs who have insurance. More LHDs reported a decrease in patient volume than an increase in patient volume, and LHDs reported serving higher percentages of patients with insurance, although neither trend has been uniform across the United States. Patients who have insurance might preferentially seek services at other sources of health care than the LHD. This might present an opportunity for LHDs to create new and expand existing partnerships. With the exception of a few states, LHDs are not currently engaged in new systems of care

Summary

What is already known about this topic?

The public health and clinical care environment is evolving in response to the Patient Protection and Affordable Care Act.

What is added by this report?

Local health department (LHD) infrastructure continues to be affected by budget decreases: one quarter of LHDs reported a lower budget in the current fiscal year compared to the previous fiscal year. LHDs reported 3,400 fewer jobs in 2014 than in 2013 and 51,700 jobs lost since 2008; 36% of LHDs reported a reduction in at least one service area, and 35% reported serving fewer patients in clinics. Up to 24% of LHDs reported expanding population-based prevention services, and LHDs reported they are exploring new collaborations with nonprofit hospitals and primary care providers.

What are the implications for public health practice?

Ongoing budget cuts and resulting personnel layoffs jeopardize the work of LHDs, which remain primary providers of health care services for many clients. As shown through their new collaborations with nonprofit hospitals and exploration of relationships with primary care providers, LHDs continue to build and explore critical local relationships that might benefit multiple stakeholders and their communities at large.

established by the ACA, such as accountable care organizations or State Innovation Models. The ACA requirement for nonprofit hospitals to complete regular CHNAs provides an opportunity for LHDs to collaborate with nonprofit hospitals. Less than 70% of LHDs are engaged in or exploring such partnerships, which might benefit multiple stakeholders and the community at large.

The findings in this report are subject to at least three limitations. First, the survey instrument includes only closed-ended questions about a limited number of topics. Consequently, other important factors not addressed by this survey might be affecting change in LHDs. Second, only descriptive statistics were presented, and no conclusions can be drawn about cause and effect. Finally, all data were self-reported by LHDs and not verified by NACCHO; therefore, the data are subject to reporting errors that cannot be identified or quantified.

LHDs face challenges and opportunities as the new public health and clinical care environments evolve. Some LHDs are adapting by reducing clinical services or expanding population-based prevention services; others continue to sustain clinical services by expanding reimbursement for those services through billing third-party payers. The ACA has also presented new opportunities for collaboration, and many LHDs are engaged in or exploring these new partnerships. Given the variations in LHD capacity to adapt to budget cuts, job losses, and reductions in clinical services while simultaneously having to implement their vision of healthy communities, LHDs will need to adopt diverse roles within their local public health systems (*7*).

[1]National Association of County and City Health Officials, Washington, D.C.
[2]Office of State, Tribal, Local and Territorial Support, CDC.

Corresponding author: Sarah J. Newman, snewman@naccho.org, 202-640-4923.

References

1. Ye J, Leep C, Newman S. Reductions of budgets, staffing, and programs among local health departments: results from NACCHO's economic surveillance surveys, 2009–2013. J Public Health Manag Pract 2015;21:126–33. http://dx.doi.org/10.1097/PHH.0000000000000074
2. Newman S, Leep C, Ye J, Robin N. The changing public health landscape: findings from the 2015 forces of change survey. Washington DC: National Association of County and City Health Officials; 2015. http://nacchoprofilestudy.org/wp-content/uploads/2015/04/2015-Forces-of-Change-Slidedoc-Final.pdf
3. Internal Revenue Service. New requirements for 501(c)(3) hospitals under the Affordable Care Act. Washington, DC: US Department of Treasury, Internal Revenue Service; 2016. https://www.irs.gov/charities-non-profits/charitable-organizations/new-requirements-for-501c3-hospitals-under-the-affordable-care-act
4. Centers for Medicare & Medicaid Services. Innovation models. Baltimore, MD: US Department of Health and Human Services, Centers for Medicare & Medicaid Services; 2016. http://innovation.cms.gov/initiatives
5. National Association of County and City Health Officials. Forces of change. Methods. 2015 forces of change survey instrument. Washington DC: National Association of County and City Health Officials; 2015. http://nacchoprofilestudy.org/forces-of-change
6. National Association of County and City Health Officials. 2015 Forces of change. Technical documentation. Washington DC: National Association of County and City Health Officials; 2015. http://nacchoprofilestudy.org/wp-content/uploads/2015/04/Forces-of-Change-Technical-Documentation-Final.pdf
7. Public Health Leadership Forum. The high achieving governmental health department in 2020 as the community chief health strategist. http://www.resolv.org/site-healthleadershipforum/files/2014/05/The-High-Achieving-Governmental-Health-Department-as-the-Chief-Health-Strategist-by-2020-Final1.pdf

Blood Lead Levels Among Children Aged <6 Years — Flint, Michigan, 2013–2016

Chinaro Kennedy, DrPH[1]; Ellen Yard, PhD[2]; Timothy Dignam, PhD[2]; Sharunda Buchanan, PhD[3]; Suzanne Condon, MS[1]; Mary Jean Brown, ScD[3]; Jaime Raymond, MPH[3]; Helen Schurz Rogers, PhD[3]; John Sarisky[3]; Rey de Castro, ScD[1]; Ileana Arias, PhD[1]; Patrick Breysse, PhD[1]

On June 24, 2016, this report was posted as an MMWR *Early Release on the* MMWR *website (http://www.cdc.gov/mmwr).*

During April 25, 2014–October 15, 2015, approximately 99,000 residents of Flint, Michigan, were affected by changes in drinking water quality after their water source was switched from the Detroit Water Authority (DWA), sourced from Lake Huron, to the Flint Water System (FWS), sourced from the Flint River.* Because corrosion control was not used at the FWS water treatment plant, the levels of lead in Flint tap water increased over time. Adverse health effects are associated with lead exposure (*1*). On January 2, 2015, a water advisory was issued because of detection of high levels of trihalomethanes, byproducts of disinfectants.†,§ Studies conducted by local and national investigators detected an increase in the prevalence of blood lead levels (BLLs) ≥5 μg/dL (the CDC reference level) among children aged <5 years living in Flint (*2*) and an increase in water lead levels after the water source switch (*3*). On October 16, 2015, the Flint water source was switched back to DWA, and residents were instructed to use filtered tap water for cooking and drinking. During that time, pregnant and breastfeeding women and children aged <6 years were advised to consume bottled water.¶ To assess the impact on BLLs of consuming contaminated drinking water, CDC examined the distribution of BLLs ≥5 μg/dL among children aged <6 years before, during, and after the switch in water source. This analysis enabled determination of whether the odds of having BLLs ≥5 μg/dL before the switch differed from the odds during the switch to FWS (before and after the January 2, 2015, water advisory was issued), and after the switch back to DWA. Overall, among 9,422 blood lead tests in children aged <6 years, 284 (3.0%) BLLs were ≥5 μg/dL during April 25, 2013–March 16, 2016. The adjusted probability of having BLLs ≥5 μg/dL was 46% higher during the period after the switch from DWA to FWS (and before the January 2, 2015, water advisory) than during the period before the water switch to FWS. Although unrelated to lead in the water, the water advisory likely reduced tap water consumption and increased consumption of bottled water. Characterizing exposure to lead contaminated drinking water among children aged <6 years living in Flint can help guide appropriate interventions.

Blood lead testing in Michigan is targeted to children living at or below the poverty level as well as to children enrolled in Medicaid. The Centers for Medicare & Medicaid Services requires all children on Medicaid to receive blood lead screening at ages 12 and 24 months, or at ages 36 and 72 months if previous screening has not been conducted. Confirmed BLLs ≥5 μg/dL are defined as having one venous blood lead test result ≥5 μg/dL or two capillary blood lead test results ≥5 μg/dL drawn within 12 weeks of each other.

Analyses of BLLs obtained during four periods were conducted. These included the period 1) before the switch from DWA to FWS (April 25, 2013–April 24, 2014); 2) after the switch from DWA to FWS, but before the water advisory was issued (April 25, 2014–January 2, 2015); 3) after the switch to FWS, and after issuance of the water advisory (January 3, 2015–October 15, 2015); and 4) after the switch back to DWA from FWS (October 16, 2015–March 16, 2016).

Michigan blood lead surveillance data were reviewed, cleaned and de-duplicated, and each tested child was assigned a unique identifier based on name, sex, date of birth and physical address. Based on the date of the blood test, results were assigned to one of the four periods. If a child had multiple BLL tests during a single period, the single highest result was used, with venous blood tests preferred over capillary tests. If a BLL of ≥5 μg/dL was reported during a given period, no subsequent blood lead tests from that child were included in the analysis. Analyses were limited to tests on children living in residences in the FWS service area; children living in areas serviced by an alternative water system were not included. Ninety-six percent of all test result addresses were geocoded. To enumerate all children aged <6 years, records of children living in the area served by FWS were accessed by reviewing data from the Michigan Care Improvement Registry**,†† and the Michigan Community Health Automated Medicaid Processing System (CHAMPS).§§ Children aged <6 years living in areas serviced

* https://www.michigan.gov/documents/snyder/FWATF_FINAL_REPORT_21March2016_517805_7.pdf.
† http://www.mlive.com/news/flint/index.ssf/2015/01/flint_water_has_high_disinfect.html.
§ https://www.cityofflint.com/wp-content/uploads/City-of-Flint-Violation-Notice-MCL-TTHM-12_16_14.pdf.
¶ https://www.epa.gov/sites/production/files/2016-03/documents/flint_oh_fsv4.pdf

** https://www.mcir.org/.
†† http://www.michigan.gov/mdhhs.
§§ http://www.michigan.gov/mdhhs/0,5885,7-339-71551_2945_5100-145006--,00.html.

by the FWS were identified in each data set using identifiers assigned by the Michigan Data Warehouse.

Age was defined as age at the time of the test. Children were excluded once they reached age 6 years. The two race categories examined were black or African American and white, the most frequently recorded races. If a child's race was missing in the database, race was recorded as other/unknown. To improve child race and sex ascertainment, the child blood lead surveillance data were merged with Michigan's CHAMPS Medicaid system, which reports race and sex more comprehensively than child blood lead surveillance data.

Prevalences were calculated to examine the proportion of BLLs ≥5 μg/dL in children aged <6 years by age group, sex, race, and season. To examine whether there was a change in the proportion of BLLs ≥5 μg/dL among children aged <6 years before, during, and after the switch to FWS, logistic regression was used to calculate odds ratios (ORs) and 95% confidence intervals (CIs). The analysis was configured to account for the possibility that some children might have had multiple BLL tests over the four periods. Multivariable regression analyses were conducted for the combined analysis period to adjust for possible confounding variables by age group, sex, race, and season.

During the assessment period, an estimated 9,622 children aged <6 years lived in residences within the area served by FWS. Among these children, 7,306 received 9,672 blood lead tests before, during, and after the water source switch period. Among these tests, 250 (2.6%) were results from a child who had a previously detected BLL ≥5 μg/dL at some point during the study period; these subsequent tests were excluded from the analysis, leaving 9,422 tests for analysis. Among these, 53% represented the highest venous blood lead test level, 46% represented the highest capillary blood lead test level in the absence of venous blood lead test, and 1% represented the highest blood lead test level among tests of unknown type.

During the period before the water source switch, among 2,408 blood lead tests, 3.1% of BLLs were ≥5 μg/dL; during the early switch period, this percentage increased to 5.0% (Table 1). The probability of having a BLL ≥5 μg/dL was significantly higher during the early switch period than the period before the switch (OR = 1.65; CI = 1.20–2.26) (Table 2).

After controlling for covariates, the probability of having BLLs ≥5 μg/dL remained significantly higher during the early period after the water source switch compared with the period before the switch (adjusted odds ratio = 1.46; CI = 1.06–2.01) (Table 3). Additionally, the probability of having BLLs ≥5 μg/dL was significantly higher for children aged 1–2 years compared with children aged <1 year and significantly higher during summer and fall months compared with winter months (Table 3).

Summary

What is already known about this topic?

In 2014, the city of Flint, Michigan, switched its water source from the Detroit Water Authority (DWA) to the Flint Water System (FWS). Drinking water can become contaminated with lead when there is corrosion in leaded plumbing. Because corrosion control was not used at the FWS water treatment plant, the levels of lead in Flint tap water increased over time.

What is added by this report?

During April 25, 2013–March 16, 2016, among 9,422 blood lead tests received by 7,306 children aged <6 years living in the area served by FWS, 3.0% of blood lead level (BLL) test results were elevated (≥5 μg/dL). The proportion of elevated BLLs was significantly higher (5.0%) during the early period of the switch from DWA to FWS compared with the previous period when residents consumed water from DWA (3.1%). After the switch back to DWA, the percentage of elevated BLLs returned to levels comparable to those found before the water source switch.

What are the implications for public health practice?

Flint residents have been recently advised by the U.S. Environmental Protection Agency that when using an approved and properly installed and maintained water filter, it is safe for persons to drink filtered tap water, including pregnant women, nursing and bottle-fed children, and children aged <6 years. Regular household tap water can be used for bathing and showering; however, young children should be prevented from drinking bath water. All children aged <6 years living in Flint should have their blood tested for lead level, if they have not had a blood lead test since October 2015. Case management should be provided to all children with elevated BLLs.

Discussion

In the United States, children with elevated BLLs typically have been exposed to lead through residential lead paint hazards often found in older homes or lead-contaminated house dust or soil (*1*). However, children and adults also can be exposed to lead through drinking water (*4*). Lead most commonly enters drinking water as a result of corrosion of leaded plumbing materials and is rarely found at the distribution point or wellhead (*5*). There are three main factors that might influence the level of lead leeching into drinking water. These include 1) whether the plumbing included lead pipes, 2) the pH of finished water, and 3) the presence or absence of mineral scale in the plumbing (*5*). Mineral scale on the inner surface of older plumbing prevents lead from leaching into drinking water; however, when mineral scale is removed or has not developed, lead might leach into drinking water from lead solder, even in "lead-free" plumbing (*5*).

Lead in drinking water has been linked to elevated blood lead concentrations (*6*). Among children aged 0–1 year who

TABLE 1. Number and percentage of elevated (≥5 μg/dL) blood lead level test results in children aged <6 years,* by assessment period, age group,† sex, race, and season — Flint, Michigan, April 2013–March 2016§

BLL testing	Before switch from DWA to FWS 04/25/2013–04/24/2014		After (early) switch to FWS (before water advisory) 04/25/2014–01/02/2015		After (late) switch to FWS (during water advisory) 01/03/2015–10/15/2015		After switch from FWS back to DWA 10/16/2015–03/16/2016	
No. of BLL tests overall	**2,408**		**1,694**		**1,990**		**3,330**	
BLL levels	**No. (%)**		**No. (%)**		**No. (%)**		**No. (%)**	
≥5 μg/dL overall	**74 (3.1)**		**84 (5.0)**		**78 (3.9)**		**48 (1.4)**	
5–9	59 (2.5)		71 (4.2)		68 (3.4)		37 (1.1)	
10–14	9 (0.4)		10 (0.6)		6 (0.3)		4 (0.1)	
15–19	2 (0.1)		2 (0.1)		0 (0)		4 (0.1)	
20–39	4 (0.2)		1 (0.1)		4 (0.2)		2 (0.1)	
≥40	0 (—)		0 (—)		0 (—)		1 (<0.1)	
Characteristic	**No. of tests**	**No. (%) with BLLs ≥5 μg/dL**	**No. of tests**	**No. (%) with BLLs ≥5 μg/dL**	**No. of tests**	**No. (%) with BLLs ≥5 μg/dL**	**No. of tests**	**No. (%) with BLLs ≥5 μg/dL**
Age group (yrs)								
<1	127	1 (0.8)	145	5 (3.4)	152	3 (2.0)	367	3 (0.8)
1–2	1,563	58 (3.7)	1,040	59 (5.7)	1,245	57 (4.6)	1,331	26 (2.0)
3–5	718	15 (2.1)	509	20 (3.9)	593	18 (3.0)	1,632	19 (1.2)
Sex								
Male	1,226	44 (3.6)	868	42 (4.8)	1,036	39 (3.8)	1,714	28 (1.6)
Female	1,168	30 (2.6)	819	42 (5.1)	943	39 (4.1)	1,604	19 (1.2)
Unknown	14	0 (—)	7	0 (—)	11	0 (—)	12	1 (8.3)
Race								
Black or African American	1,337	38 (2.8)	1,020	56 (5.5)	1,159	47 (4.1)	2,003	29 (1.4)
White	571	25 (4.4)	435	24 (5.5)	574	23 (4.0)	894	16 (1.8)
Other/unknown	500	11 (2.2)	239	4 (1.7)	257	8 (3.1)	433	3 (0.7)
Season								
Winter (December–February)	530	7 (1.3)	120	3 (2.5)	327	6 (1.8)	2584	35 (1.4)
Spring (March–May)	606	18 (3.0)	237	7 (3.0)	551	15 (2.7)	321	7 (2.2)
Summer (June–August)	588	19 (3.2)	653	39 (6.0)	544	25 (4.6)	0	0 (—)
Fall (September–November)	684	30 (4.4)	684	35 (5.1)	568	32 (5.6)	425	6 (1.4)

Abbreviations: BLL = blood lead level; DWA = Detroit Water Authority; FWS = Flint Water System.
* All children were Flint residents, defined as living in a residence in the FWS service area.
† At time of test.
§ Some children with BLLs <5 μg/dL were counted in multiple periods.

consume, on average, 1,200 mL of drinking water per day, a lead concentration in water of 20 parts per billion might be sufficient to raise the blood lead level of a child from 0 to 5 μg/dL in the absence of other lead sources (*7*).

Very young children consume more water per unit of body mass than do older children and adults, and they are more likely to engage in hand-to-mouth behaviors that put them at higher risk for exposure to lead in house dust and soil. Additionally, BLLs in children tend to rise in warm weather months, a phenomenon that might be related to differential seasonal distribution of lead dust in houses as well as higher exposure to street dust associated with increased outdoor activity (*8*). However, even after controlling for age and season, the period after the water source was switched from DWA to FWS, and before the water advisory was issued, remained independently associated with an increased probability of BLLs ≥5 μg/dL among children aged <6 years living in the area served by FWS.

The findings in this report are subject to at least five limitations. First, spurious associations might have resulted from failure to control for all confounders because substantial information for certain covariates (e.g., race) was either not collected or missing. Second, although this analysis demonstrates increased prevalence of BLLs ≥5 μg/dL coincident with the switch to FWS, its observational nature limits attribution exclusively to the switch in drinking water source. Third, exposure to other known sources of lead that might have contributed to a child's probability of being exposed was not ascertained. Fourth, infants who are primarily fed formula mixed with tap water are likely to have been more exposed to contaminated water; however, few children aged <1 year were tested. Thus, the impact of the high water lead levels for this age group might have been underestimated. Finally, the decline in the proportion of BLLs ≥5 μg/dL after the switch back to DWA might have resulted, in part, to increased and continuing bottled water consumption rather than the switch back to DWA, reflecting a change in behavior, rather than an effect of the change in municipal drinking water source.

TABLE 2. Odds ratios (ORs)* comparing elevated blood lead levels (BLLs) (≥5 μg/dL) during three water source switch periods with BLLs before the first switch, among children aged <6 years,† by age group,§ sex, race, and season — Flint, Michigan, April 2013–March 2016

Characteristic	Before switch from DWA to FWS 04/25/2013–04/24/2014	After (early) switch to FWS (before water advisory) 04/25/2014–01/02/2015 OR (95% CI)	After (late) switch to FWS (during water advisory) 01/03/2015–10/15/2015 OR (95% CI)	After switch from FWS back to DWA 10/16/2015–03/16/2016 OR (95% CI)
Overall	**Referent**	**1.65 (1.20–2.26)¶**	**1.29 (0.93–1.78)**	**0.46 (0.32–0.67)¶**
Age group (years)				
<1	Referent	4.50 (0.52–39.0)	2.54 (0.26–24.7)	1.04 (0.11–10.1)
1–2	Referent	1.56 (1.08–2.26)¶	1.24 (0.86–1.81)	0.52 (0.32–0.83)¶
3–5	Referent	1.92 (0.98–3.78)	1.47 (0.74–2.94)	0.55 (0.28–1.10)
Sex				
Male	Referent	1.37 (0.89–2.10)	1.05 (0.68–1.63)	0.45 (0.28–0.72)¶
Female	Referent	2.05 (1.28–3.31)¶	1.64 (1.01–2.66)¶	0.46 (0.26–0.81)¶
Race				
Black or African American	Referent	1.99 (1.31–3.02)¶	1.45 (0.94–2.23)	0.50 (0.31–0.82)¶
White	Referent	1.28 (0.72–2.26)	0.91 (0.51–1.62)	0.40 (0.21–0.75)¶
Other/Unknown	Referent	0.76 (0.24–2.40)	1.43 (0.57–3.59)	0.31 (0.09–1.12)
Season				
Winter (December–February)	Referent	1.92 (0.49–7.51)	1.40 (0.47–4.19)	1.03 (0.45–2.32)
Spring (March–May)	Referent	1.00 (0.41–2.41)	0.91 (0.46–1.83)	0.73 (0.30–1.76)
Summer (June–August)	Referent	1.90 (1.09–3.33)¶	1.44 (0.79–2.65)	—
Fall (September–November)	Referent	1.18 (0.71–1.94)	1.30 (0.78–2.17)	0.31 (0.13–0.76)¶

Abbreviations: CI = confidence interval; DWA = Detroit Water Authority; FWS = Flint Water System.
* Adjusted for correlation among children with blood lead measurements in more than one period.
† All children were Flint residents, defined as living in a residence in the FWS service area.
§ At time of test.
¶ Statistically significant OR.

TABLE 3. Multivariable adjusted odds ratios (AORs)* comparing odds of elevated blood lead levels (≥5 μg/dL) among children aged <6 years,† by selected covariates§ — Flint, Michigan, April 2013–March 2016

Covariate	AOR (95% CI)
Period	
Before switch from DWA to FWS	Referent
After (early) switch to FWS (before water advisory)	1.46 (1.06–2.01)¶
After (late) switch to FWS (after water advisory)	1.28 (0.92–1.76)
After switch from FWS back to DWA	0.75 (0.51–1.12)
Age group (yrs)**	
<1	Referent
1–2	2.25 (1.25–4.06)¶
3–5	1.36 (0.73–2.53)
Season	
Winter (December–February)	Referent
Spring (March–May)	1.41 (0.91–2.16)
Summer (June–August)	2.14 (1.44–3.18)¶
Fall (September–November)	2.25 (1.57–3.22)¶

Abbreviations: CI = confidence interval; DWA = Detroit Water Authority; FWS = Flint Water System.
* Adjusted for correlation among children with blood lead measurements in more than one period.
† All children were Flint residents, defined as living in a residence in the FWS service area.
§ The most parsimonious model is shown; sex and race were no longer statistically significant in the full model.
¶ Statistically significant AOR.
** At time of test.

There might be multiple sources of early childhood lead exposure (*9*) in areas with houses built before lead paint use in the United States was banned in 1978 (*10*). However, this analysis suggests increased lead exposure related to consuming contaminated water in Flint. Flint residents have been recently advised by the U.S. Environmental Protection Agency that when using an approved and properly installed and maintained water filter, it is safe for persons to drink filtered tap water, including pregnant women, nursing and bottle-fed children, and children aged <6 years.¶¶ Regular household tap water can be used for bathing and showering; however, young children should be prevented from drinking bath water. Efforts to provide case management to all children residing in Flint with BLLs ≥5 μg/dL began in 2016. All children aged <6 years living in Flint should have their blood tested for lead, if they have not had a blood lead test since October 2015.

¶¶ https://www.epa.gov/flint/filter-study.

Acknowledgments

Bob Scott, PhD, Martha Stanbury, MSPH, Michigan Department of Health and Human Services; Brian Kaplan, MS, MA, Melissa Smith, MA, Steven Bullard, JD, Mark Johnson, PhD, Agency for Toxic Substances Disease Registry; Dana Flanders, MD, ScD, Rollins School of Public Health, Emory University, Atlanta, Georgia; Troy Ritter, PhD, Division of Emergency and Environmental Health Services, National Center for Environmental Health, CDC; Shailen Banerjee, PhD, James Hodge, JD, National Center for Environmental Health, CDC.

[1]Office of the Director, National Center for Environmental Health, CDC; [2]Division of Environmental Health and Health Effects, National Center for Environmental Health, CDC; [3]Division of Emergency and Environmental Health Services, National Center for Environmental Health, CDC.

Corresponding author: Chinaro Kennedy, gjn5@cdc.gov, 770-488-3639.

References

1. CDC. Managing elevated blood lead levels among young children: recommendations from the Advisory Committee on Childhood Lead Poisoning Prevention. Atlanta, GA: US Department of Health and Human Services, CDC; 2002. https://www.cdc.gov/nceh/lead/casemanagement/managingEBLLs.pdf
2. Hanna-Attisha M, LaChance J, Sadler RC, Champney Schnepp A. Elevated blood lead levels in children associated with the Flint drinking water crisis: a spatial analysis of risk and public health response. Am J Public Health 2016;106:283–90. http://dx.doi.org/10.2105/AJPH.2015.303003
3. Roy S. Our sampling of 252 homes demonstrates a high lead in water risk: Flint should be failing to meet the EPA lead and copper rule. September 8, 2015. Blacksburg, VA: Virginia Tech Research Team; 2015. http://flintwaterstudy.org/2015/09/our-sampling-of-252-homes-demonstrates-a-high-lead-in-water-risk-flint-should-be-failing-to-meet-the-epa-lead-and-copper-rule/
4. Cosgrove E, Brown MJ, Madigan P, McNulty P, Okonski L, Schmidt J. Childhood lead poisoning: case study traces source to drinking water. J Environ Health 1989;52:346–9.
5. Chin D, Karalekas PCJ. Lead product use survey of public water supply distribution systems throughout the United States. In: proceedings of plumbing materials and drinking water quality seminar; May 16–17, 1984; Cincinnati, Ohio. EPA 600/9-85-007:110–23. Washington DC: US Environmental Protection Agency, 1985.
6. US Environmental Protection Agency. Air quality criteria document for lead (final), 2006 vol. 1. Washington, DC: US Environmental Protection Agency; 2006.
7. Triantafyllidou S, Gallagher D, Edwards M. Assessing risk with increasingly stringent public health goals: the case of water lead and blood lead in children. J Water Health 2014;12:57–68. http://dx.doi.org/10.2166/wh.2013.067
8. Yiin LM, Rhoads GG, Lioy PJ. Seasonal influences on childhood lead exposure. Environ Health Perspect 2000;108:177–82. http://dx.doi.org/10.1289/ehp.00108177
9. Jones RL, Homa DM, Meyer PA, et al. Trends in blood lead levels and blood lead testing among US children aged 1 to 5 years, 1988-2004. Pediatrics 2009;123:e376–85. http://dx.doi.org/10.1542/peds.2007-3608
10. Davidson CI, Rabinowitz M. Lead in the environment: from sources to human receptors. In: Needleman HL, ed. Human lead exposure. Boca Raton, FL: CRC Press; 1991.

Notes from the Field

Four Multistate Outbreaks of Human *Salmonella* Infections Linked to Small Turtle Exposure — United States, 2015

Kelly Gambino-Shirley, DVM [1,2]; Lauren Stevenson, MHS[2]; Katherine Wargo, MPH[2]; Laura Burnworth, MPH[2]; Jonathan Roberts, DVM[3]; Nancy Garrett[2]; Susan Van Duyne, MA[2]; Gillian McAllister[2]; Megin Nichols, DVM[2]

In August 2015, the Food and Drug Administration (FDA) notified CDC of a consumer complaint involving *Salmonella* Sandiego infection in a child (the index patient), who had acquired a small turtle (shell length <4 inches [<10 cm]) at an Alabama flea market. The subsequent investigation, which included examining data from PulseNet, the national molecular subtyping network for foodborne disease surveillance, identified four multistate *Salmonella* outbreaks: two involving *Salmonella* Sandiego and two involving *Salmonella* Poona. These serotypes have been linked to small turtles in previous outbreaks (*1*,*2*). Although selling small turtles as pets in the United States has been banned since 1975 (*3*), illegal sales still occur at discount stores and flea markets and by street vendors. CDC investigated to determine the extent of the outbreaks and prevent additional infections.

For this investigation, a case was defined as infection with *Salmonella* serotypes Sandiego or Poona with the pulse-field gel electrophoresis patterns *XbaI* JL6X01.0104, JL6X01.0544, JL6X01.0055, JLXX01.0030, or JLXX01.0053 in a person with illness onset January 1–December 31, 2015. A total of 124 cases from 22 states were identified. Median patient age was 7 years (range <1–82 years); 51 patients (41%) were aged <5 years, and 59 (49%) were female. Among 108 patients with available information, 36 (33%) were hospitalized. Thirteen (36%) of the 36 hospitalized patients were aged <5 years. No deaths were reported. Fifty-eight (70%) of 83 patients with ethnicity information were Hispanic.

A total of 104 patients or their caregivers were interviewed; 50 patients (48%) had turtle exposure. Among the 50 patients with reported turtle exposure, the median age was 3 years (range <1–77 years), 30 (60%) were aged <5 years, and 25 (50%) were female. Of the 50 patients with turtle exposure, 48 had information on hospitalization; 18 of the 48 (38%) were hospitalized. Nine of those hospitalized were aged <5 years. Twenty-eight (72%) of 39 patients with ethnicity information were Hispanic. Turtle and turtle environment samples were collected from nine patients' homes. Of these, 21 isolates of *Salmonella* were culture-positive: 17 matched the outbreak strains, two were *Salmonella* Paratyphi B var L-tartrate+, and two were *Salmonella* Pomona (Table).

TABLE. *Salmonella* serotypes and pulsed-field gel electrophoresis (PFGE) *XbaI* patterns, by source — United States, 2015

Serotype	PFGE *XbaI* pattern	Patients with turtle exposure*/ total patients	No. of isolates cultured positive by source†		
			Patient	Pet turtles and turtle environments	Farm A pond water
Sandiego	JLXX01.0030	8/13	17	0	0
	JLXX01.0053	7/18	21	3	0
Poona	JL6X01.0104	27/52	60	11	0
	JL6X01.0055	7/20	25	2	0
	JL6X01.0544	1/1	1	1	0
Paratyphi B var L-tartrate+	JKXX01.0225	0	0	2	0
Berta	JAXX01.0025	0	0	0	1
Braenderup	JBPX01.0884	0	0	0	1
Pomona	POMX01.0002	0	0	2	2
	POMX01.0098	0	0	0	1

* Information obtained from patient interviews.
† Specimens/samples might have more than one isolate from a single source.

An FDA consumer safety officer investigating the flea market where the index patient's turtle was obtained traced the turtle's origin to farm A (FDA's Center for Veterinary Medicine did not pursue legal action regarding the sale by farm A of small turtles to the flea market vendor). Pond water samples from farm A yielded cultures of *Salmonella* (Table). Although the samples from turtle farm A did not yield the 2015 outbreak strains, two of the three *Salmonella* Pomona isolates from pond water matched isolates from a patient's pet turtle's environment.

The high proportion of patients aged <5 years in these outbreaks emphasizes the risk for illness among young children with small turtles as pets. This finding indicates education is needed to address the risk to children for *Salmonella* infections from small turtles and other reptiles. Many patients in these outbreaks were Hispanic, which highlights the importance of multilingual messages for effective communication. During these outbreaks, the announcement and prevention messages regarding safe handling of pet reptiles and amphibians were translated into Spanish and posted on the "CDC en Español" website. To ensure wider dissemination, information was also provided to a major Spanish-language news agency.

Transient vendors continue to be a source of illegal sales of small turtles. Educational campaigns at schools, child care centers, carnivals, and flea markets regarding the risk for *Salmonella* from contact with turtles are important to prevent infections among children.

[1]Epidemic Intelligence Service, CDC; [2]Division of Foodborne, Waterborne, and Environmental Diseases, National Center for Emerging and Zoonotic Infectious Diseases, CDC; [3]Louisiana Department of Agriculture and Forestry.

Corresponding author: Kelly Gambino-Shirley, KGambinoShirley@cdc.gov, 404-639-1461.

References

1. Basler C, Bottichio L, Higa J, Prado B, Wong M, Bosch S. Notes from the field: multistate outbreak of human *Salmonella* Poona infections associated with pet turtle exposure—United States, 2014. MMWR Morb Mortal Wkly Rep 2015;64:804. http://dx.doi.org/10.15585/mmwr.mm6429a7
2. Walters MS, Simmons L, Anderson TC, et al. Outbreaks of salmonellosis from small turtles. Pediatrics 2016;137:e20151735. http://dx.doi.org/10.1542/peds.2015-1735
3. Turtles intrastate and interstate requirements, 21 C.F.R. Sect. 1240.62 (2015). https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr=1240.62

Announcement

CDC's 70th Anniversary

July 1, 2016, marks the 70th anniversary of the establishment of CDC. Since the agency's launch as the Communicable Disease Center on July 1, 1946, CDC's primary mission has been improving public health in the United States and around the world through prevention and preparedness. In the seven decades since CDC's founding, the agency has grown in size and mission and is recognized as the nation's premiere health promotion, disease prevention, and emergency preparedness agency, and a global leader in public health. CDC's mission has progressed beyond communicable disease control and now encompasses noninfectious diseases, injury prevention, and environmental and occupational health.

During the first decade of the 21st century, CDC contributed to major public health achievements, including reductions in child mortality; improvements in prevention and control of vaccine-preventable diseases, human immunodeficiency virus infection, acquired immune deficiency syndrome, malaria, and tuberculosis; reductions in deaths from chronic diseases; control of the global tobacco epidemic; and declines in deaths and injuries from motor vehicle crashes (*1*). From fighting malaria in the aftermath of World War II to protecting the public from infectious and noninfectious diseases, injuries, and environmental and occupational health threats, to preventing disabilities and combating pandemic influenza and Ebola and Zika viruses, CDC remains committed to its mission of protecting health and saving lives.

Reference

1. CDC. Ten great public health achievements—United States, 2001–2010. MMWR Morb Mortal Wkly Rep 2011;60:619–23.

Errata

Vol. 63, No. 7

In the report, "Declines in Student Obesity Prevalence Associated with a Prevention Initiative — King County, Washington, 2012," the following errors occurred.

On page 155, a portion of the second sentence of the fourth paragraph should have read, ". . . the odds of a student being obese in 2012 being **8%** less than in 2004 (odds ratio [OR] = **0.92**; 95% confidence interval [CI] = **0.86–0.99**)."

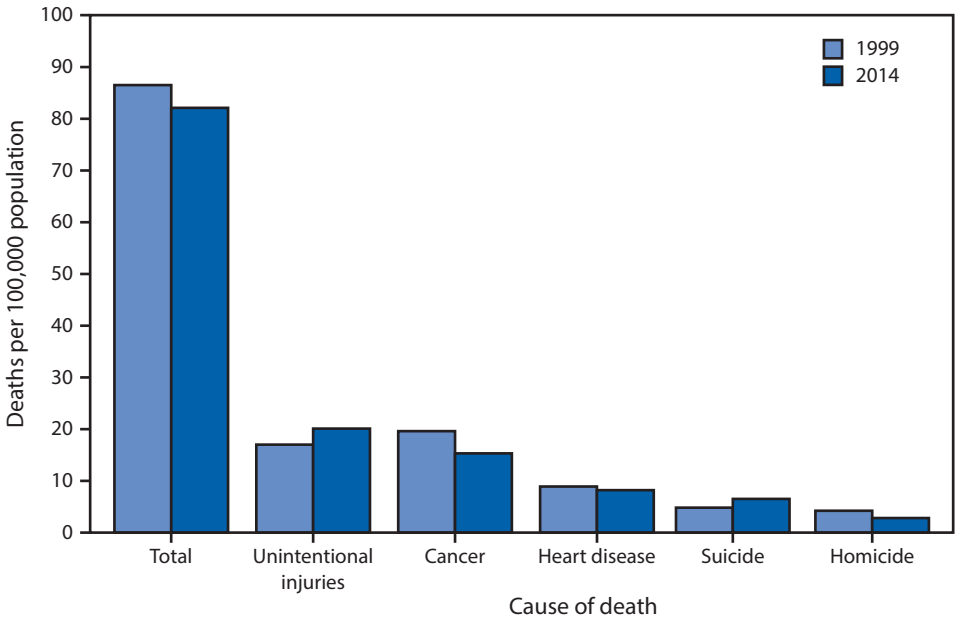
On page 156, the sixth sentence of the first paragraph should have read, "Comparing CPPW and non-CPPW students, the 2010 to 2012 change in obesity was **not** significantly different (p = **0.4** for interaction term)." The seventh sentence should have read, "Before the CPPW intervention in 2010, obesity prevalence was stable in **both** the CPPW **and non-CPPW** districts."

Also on page 156, in Figure 2 and Table 2, the values for obesity prevalence in non-CPPW school districts for the years 2004, 2006, and 2012 should have been presented as **7.2 (CI = 6.5–7.9), 7.0 (CI = 6.2–7.8)**, and **5.7 (CI = 5.0–6.5)**, respectively.

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Age-Adjusted Death Rates* for Females Aged 15–44 Years, by the Five Leading Causes of Death† — United States, 1999 and 2014



* All differences in rates were statistically significant ($p<0.05$). Age-adjusted rates are per 100,000 standard population.
† Unintentional injuries are identified with *International Classification of Diseases, 10th Revision* codes V01–X59, Y85–Y86; C00–C97 for cancer; I00–I09, I11, I13, I20–I51 for heart disease; U03, X60–X84, Y87.0 for suicide; and U01–U02, X85–Y09,Y87.1 for homicide.

The age-adjusted death rate for females aged 15–44 years was 5% lower in 2014 (82.1 per 100,000 population) than in 1999 (86.5). Among the five leading causes of death, the age-adjusted rates of three were lower in 2014 than in 1999: cancer (from 19.6 to 15.3, a 22% decline), heart disease (8.9 to 8.2, an 8% decline), and homicide (4.2 to 2.8, a 33% decline). The age-adjusted death rates for two of the five causes were higher in 2014 than in 1999: unintentional injuries (from 17.0 to 20.1, an 18% increase) and suicide (4.8 to 6.5, a 35% increase). Unintentional injuries replaced cancer as the leading cause of death in this demographic group.

Source: CDC/NCHS, National Vital Statistics System, 1999 and 2014, Mortality. CDC Wonder online database. http://wonder.cdc.gov/ucd-icd10.html.

Reported by: Sally C. Curtin, MA, SCurtin@cdc.gov, 301-458-4142; Donna L. Hoyert, PhD.

The *Morbidity and Mortality Weekly Report (MMWR)* Series is prepared by the Centers for Disease Control and Prevention (CDC) and is available free of charge in electronic format. To receive an electronic copy each week, visit *MMWR*'s free subscription page at *http://www.cdc.gov/mmwr/mmwrsubscribe.html*. Paper copy subscriptions are available through the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone 202-512-1800.

Readers who have difficulty accessing this PDF file may access the HTML file at *http://www.cdc.gov/mmwr/index2016.html*. Address all inquiries about the *MMWR* Series, including material to be considered for publication, to Executive Editor, *MMWR* Series, Mailstop E-90, CDC, 1600 Clifton Rd., N.E., Atlanta, GA 30329-4027 or to mmwrq@cdc.gov.

All material in the *MMWR* Series is in the public domain and may be used and reprinted without permission; citation as to source, however, is appreciated.

Use of trade names and commercial sources is for identification only and does not imply endorsement by the U.S. Department of Health and Human Services.

References to non-CDC sites on the Internet are provided as a service to *MMWR* readers and do not constitute or imply endorsement of these organizations or their programs by CDC or the U.S. Department of Health and Human Services. CDC is not responsible for the content of these sites. URL addresses listed in *MMWR* were current as of the date of publication.

ISSN: 0149-2195 (Print)