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Adult Blood Lead Epidemiology and Surveillance — United States, 1998–2001

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On the cover: Removal of lead-based paints (courtesy of Aaron Sussell).

CONTENTS

Adult Blood Lead Epidemiology and Surveillance — United States, 1998–2001

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Abstract

Problem/Condition: Elevated blood lead levels (BLLs) in adults can damage the cardiovascular, central nervous, reproductive, hematologic, and renal systems. The majority of cases are workplace-related. U.S. Department of Health and Human Services recommends that BLLs among all adults be reduced to <25 µg/dL. The highest BLL acceptable by standards of the U.S. Occupational Safety and Health Administration is 40 µg/dL. The mean BLL of adults in the United States is <3 µg/dL.

Reporting Period: This report covers cases of adults (aged ≥16 years) with BLLs ≥25 µg/dL, as reported by 25 states during 1998–2001.

Description of System: Since 1987, CDC has sponsored the state-based Adult Blood Lead Epidemiology and Surveillance (ABLES) program to track cases of elevated BLLs and provide intervention consultation and other assistance. Overall ABLES program data were last published in 1999 for the years 1994–1997. This report provides an update with data from 25 states reporting for ≥2 years during 1998–2001. During that period, the ABLES program funded surveillance in 21 states — Alabama, Arizona, Connecticut, Iowa, Maryland, Massachusetts, Michigan, Minnesota, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Texas, Washington, Wisconsin, and Wyoming. Four additional states — California, Nebraska, New Hampshire, and Utah — contributed data without CDC funding.

Results: During 1998–2001, the overall program's annual mean state prevalence rate for adults with BLLs ≥25 µg/dL was 13.4/100,000 employed adults. This compares with 15.2/100,000 for 1994–1997. Yearly rates were 13.8 (1998), 12.9 (1999), 14.3 (2000), and 12.5 (2001).

For adults with BLLs ≥40 µg/dL, the overall program's annual mean state prevalence rate during 1998–2001 was 2.9/100,000 employed adults. This compares with 3.9/100,000 for 1994–1997. Yearly rates were 3.3 (1998), 2.5 (1999), 2.9 (2000), and 2.8 (2001).

Interpretation: Although certain limitations exist, the overall ABLES data indicate a declining trend in elevated BLLs among employed adults.

Public Health Actions: ABLES-funded states increased from 21 to 35 in 2002, and more detailed reporting requirements were put into effect. These, and other improvements, will enable the ABLES program to work more effectively toward its 2010 target of eliminating all cases of BLLs ≥25 µg/dL in adults caused by workplace exposures.

Introduction

Inorganic Lead

Inorganic lead is a bluish gray metal valued since ancient times because of its useful properties (e.g., low melting point, pliability, and resistance to corrosion). The ancient Romans and Greeks first discovered its toxic effects. Lead is ubiquitous in U.S. urban environments because of the widespread use of lead compounds in industry, gasoline, and paints during the 1900s (*1–3*).

Adult Lead Exposure

Adult exposure to inorganic lead occurs when dust and fumes are inhaled and when lead from lead-contaminated hands, food, water, cigarettes, and clothing is ingested. Lead absorbed through the respiratory and digestive systems is released into the blood, which distributes the lead throughout the body. Approximately 90% of total body lead content is accumulated in the bones, where it is stored for decades. Lead in bones continues to be released gradually back into the body after the external environmental exposure occurs (*1–3*).

Health Effects of Adult Lead Exposure

The adverse health effects of elevated exposure to lead among adults include damage to the cardiovascular, central nervous, reproductive, hematologic, and renal systems (*1–3*). Studies have reported that adults with blood lead levels (BLLs) of 25–60 µg/dL can exhibit nonspecific symptoms, including irritability, fatigue, headache, sleep disturbance, decreased libido, and depressed mood (*4*). Studies have also reported adverse health effects, including hypertension, subtle or subclinical central nervous system deficits, and adverse reproductive outcomes among adults exposed to lead at concentrations below the existing regulatory exposure limits of 40 µg/dL (*5–9*). Although the significance of these subclinical effects on long-term health continues to be studied, the U.S. Department of Health and Human Services (DHHS) recommends that BLLs be reduced to <25 µg/dL among all adults as a preventive health measure (*10,11*).

Lead readily crosses the placenta. The source of lead exposure for a fetus might be the mother's recent exposure to lead or mobilization of lead into the blood during pregnancy from bone stores because of past exposure. The American Conference of Governmental Industrial Hygienists (ACGIH) advises women of child-bearing age, if their BLL is >10 µg/dL, they are at risk for delivering a child with a BLL >10 µg/dL (*12*) — the level of concern in CDC's pediatric guidelines.

Sources of Adult Lead Exposures

Data reported to the Adult Blood Lead Epidemiology and Surveillance Program (ABLES), suggest >90% of elevated BLL cases among adults result from workplace exposure (*13,14*). National Health and Nutrition Examination Survey data indicate that by 1991–1994, the geometric mean BLL of U.S. adults had dropped to 2.1, 3.1, and 3.4 µg/dL for persons aged 20–49, 50–69, and ≥70 years, respectively (*15*). This compares with a geometric mean of 13.1 µg/dL for persons aged 20–74 years for the period 1976–1980 (*16*). Although the mean BLL of the entire U.S. population is relatively low, adult workers continue to be exposed to high concentrations of lead in >100 industries, including battery manufacturing, painting, nonferrous smelting, radiator repair, brass and bronze foundries, pottery production, scrap metal recycling, firing ranges, and wrecking and demolition (*11*).

Elevated BLLs among adults can also be caused by exposure to nonoccupational (i.e., ambient or environmental) sources of lead (e.g., recreational target shooting, home remodeling, casting bullets and fishing weights, making stained glass and ceramics, cookware, pica behavior [ingestion of nonfood items], traditional remedies, drinking homemade alcoholic brews, and retaining bullets in or near a synovial joint). When occupational exposure is not proven or seems unlikely, clinicians should investigate these factors as potential cases of elevated BLLs (*11*).

Adult Blood Lead Epidemiology and Surveillance Program

Since 1987, CDC's National Institute for Occupational Safety and Health (NIOSH) has sponsored ABLES, a state-based program that tracks laboratory-reported BLLs among adults, and teams with other agencies to intervene and help prevent further high-level lead exposures. For states that report to ABLES, the primary sources of BLL reports are public and private laboratories; secondary sources are physicians. ABLES requires that laboratory reporting to the state health department (or other designee) of BLL results, both occupational and nonoccupational, be mandatory under state law. Laboratory reports include basic demographic information with unique identifiers to differentiate between new and ongoing cases and to account for multiple reports regarding the same person. Those reporting are also urged to include information regarding occupations and industries, lead-related avocations, and whether the laboratory is approved for occupational lead testing by the Occupational Safety and Health Administration (OSHA). The minimum BLL reporting requirement varies from state to state. Moreover, reporting of all BLLs is encouraged, because these data are useful for

analyzing exposure trends and for providing the basis for future ABLES consultation and education on intervention strategies.

The public health objective of the ABLES program, as stated in *Healthy People 2010*, is to reduce the number of persons with BLLs ≥25 µg/dL from work exposures; the target is to reduce that number to zero by 2010 (*10*). In collaboration with the ABLES program, the Council of State and Territorial Epidemiologists (CSTE) has adopted a surveillance case definition: an adult (aged ≥16 years) with a venous (or comparable) BLL ≥25 µg/dL of whole blood (*17*).

The ABLES program seeks to accomplish its objective by continuing to improve its surveillance programs and helping state health and other agencies to effectively intervene to prevent further lead exposures. Intervention strategies implemented by ABLES-reporting states include conducting follow-up interviews with physicians, employers, and workers; investigating work sites; delivering technical assistance regarding exposure reduction or prevention; providing referrals for consultation and enforcement; and developing and disseminating educational materials and outreach programs. The educational materials developed by ABLES-reporting states are listed on, or linked to, the ABLES website.*

The ABLES program is a complete surveillance program that entails not only enumerating adults with elevated BLLs, but also analyzing and reporting data, helping appropriate agencies intervene to prevent further exposures, and testing the effectiveness of those interventions. State and federal ABLES participants and partners have published analyses of their intervention activities (*18–22*), surveillance data, and investigations (*13,14,23–27*).

To coordinate their reporting and intervention activities for maximum efficiency, state ABLES programs are strongly encouraged to develop effective working relationships with the childhood lead prevention programs in their states. An estimated 2%–3% of children with BLL ≥10 µg/dL reach those levels from exposure to lead brought home from the workplace on the clothes or in the vehicles of their adult caregivers (*23*). State ABLES programs are also encouraged to develop effective working relationships with other federal and state agencies involved in preventing adult lead poisoning (e.g., OSHA, U.S. Department of Housing and Urban Development, U.S. Environmental Protection Agency, U.S. Department of Transportation, and U.S. Department of Defense).

Overall ABLES program data were last published in the *MMWR* in 1999 for 1994–1997 (*28*). This report provides data for 1998–2001. This will be the last report for ABLES data collected under the old aggregate format. Increased data requirements that took effect in 2002 will track adult BLLs by age, sex, and industry.

* Available at http://www.cdc.gov/niosh/ables.html.

Methods

Biological Indices

The best method for monitoring exposure to lead is measuring BLLs in whole blood, although other biological indices exist. As the BLL increases, the frequency and severity of symptoms associated with lead exposure also increase (albeit with considerable variability). With other indices of lead exposure, no such specific relationship with symptoms has been established (*1–3*). Furthermore, BLL is responsive to recent exposures — the cases most amenable to preventive intervention. Among other indices, measurement of protoporphyrin (free or zinc protoporphyrin) concentration in red blood cells can be an accurate indicator of inhibition of heme synthesis by lead. However, other causes of elevated protoporphyrin levels exist (e.g., iron-deficiency anemia and inflammatory conditions) (*29*). Lead concentrations can be measured in urine, teeth, and hair, but these measurements are not as reliable as BLLs. An experimental technique, radiographic fluorescence, provides a more accurate method for determining long-term, cumulative lead exposure and the total body burden of lead (*7*), but only a limited number of research facilities in the United States and Canada provide bone lead measurements.

Testing Requirements

Permissible exposure limits for lead in the workplace and worker monitoring are regulated by OSHA standards, which differ slightly for general industry† (*30*) and the construction industry§ (*31*). A detailed comparison of the standards has been published elsewhere (*32*). When airborne lead concentrations exceed the action level of 30 µg/m^3, OSHA requires medical surveillance, which includes biologic monitoring of BLLs by an OSHA-approved laboratory. Under the OSHA general industry standard, workers must be removed from substantial lead exposure when their BLLs are ≥60 µg/dL or when they averaged ≥50 µg/dL during the previous six months, or when workers have detected medical conditions that place them at increased risk for material impairment to health from lead exposure. After workers have been medically removed, they may return to work when their BLLs fall to 40 µg/dL. Thus, 40 µg/dL can be construed as the highest BLL deemed acceptable under OSHA lead standards.

† 29 CFR 1910.1025.
§ 29 CFR 1926.62.

Surveillance Reporting

In this report, ABLES prevalence is reported according to two benchmarks: BLLs ≥25 µg/dL, the limit set by *Healthy People 2010* in its public health objective (*10*); and ≥40 µg/dL, the limit at which OSHA will permit a worker to return to work after being medically removed. To enable year-to-year and state-to-state comparisons of ABLES data, adjustments were made to account for the changing number and roster of states, and to control for their different populations. Prevalence rates were established by expressing cases of BLLs ≥25 and ≥40 µg/dL for each reporting state as annual rates per 100,000 persons employed (aged ≥16 years). State employment data were obtained from the Bureau of Labor Statistics, Current Population Survey [¶] (*33*).

Results

The data reported here are for the 25 state ABLES programs reporting for ≥2 years during 1998–2001 (Figure 1). These data can differ slightly from previous ABLES reports that included states no longer reporting (states that stopped reporting and the years they did report: Maine 1994–1998, Illinois 1994–1996, New Mexico 1997, and Vermont 1994 and 1997).

For 1998–2001, a total of 25 ABLES states reported 41,984 adults with BLLs ≥25 µg/dL and 8,265 adults with BLLs ≥40 µg/dL. The yearly totals for BLLs ≥25 µg/dL were 10,459 (1998) with 24 of 25 states reporting; 10,310 (1999) with 25 states reporting; 11,272 (2000) with 25 states reporting; and 9,943 (2001) with 23 of 25 states reporting (Table 1). The yearly totals for BLLS ≥40 µg/dL were 2,071 (1998); 1,933 (1999); 2,252 (2000); and 2,009 (2001) (Table 2).

More populous ABLES states reported more cases (Tables 1 and 2). To illustrate the degree of variance among states, mean annual percentages by state are presented for adults with BLLs ≥25 µg/dL for 1998–2001 (Figure 2). These percentages were derived by 1) calculating the mean number of annual cases for each state during 1998–2001; 2) adding those means; and 3) calculating the percentage of this sum of means for each state. On average, Pennsylvania, Ohio, California, and New York — when combined — reported 50% of the adult cases with BLLs ≥25 µg/dL, whereas Arizona, Oklahoma, South Carolina, Utah, and Wyoming reported <1% each (Figure 2). Using the same method for cases with BLLs ≥40 µg/dL, on average, the same four populous states, plus North Carolina, combined to report 55% of the cases, whereas Arizona, Nebraska, Oklahoma, Utah, and Wyoming reported, on average, <1% each (Figure 3).

Year-to-year comparisons were enabled by expressing cases of BLLs ≥25 and ≥40 µg/dL for each reporting state as annual rates per 100,000 persons employed (aged ≥16 years). Mean annual state rates for the overall ABLES program were then calculated for each year during 1998–2001 (Figure 4). State-to-state comparisons of 1998-2001 data were made in a similar fashion. The 25 ABLES states are displayed in order of their 4-year mean annual rates for adults with BLLs ≥25 µg/dL (Figure 5). The overall mean for the 25 states for 1998-2001 was 13.4/100,000 employed. ABLES states are also displayed in order of their 4-year mean annual rates for adults with BLLs ≥40 µg/dL (Figure 6). The overall mean for the 25 states for 1998-2001 was 2.9/100,000.

To make state-to-state comparisons of 1998–2001 data with 1994–1997 data, only 20 of the 25 ABLES states — those that reported for ≥2 years during both 4-year periods — were used (Figures 7 and 8). The mean annual rates for each state were then calculated, as well as the mean annual rates for the program overall, during each 4-year period. For adults with BLLs ≥25 µg/dL, 17 of 20 states reported lower rates for 1998–2001, compared with 1994–1997 (only Alabama, North Carolina and Maryland reported higher rates). For the ABLES program overall, the mean annual rates were 15.2/100,000 for 1994–1997 compared with 13.4/100,000 for 1998–2001 (Figure 7). Using the same method for adults with BLLs ≥40 µg/dL, 16 of 20 states reported lower rates for 1998–2001, compared with 1994-1997 (only Alabama, North Carolina, and Pennsylvania reported higher rates; Maryland's rate did not change). For the program overall, the mean annual rates for adults with BLLs ≥40 µg/dL were 3.9/100,000 for 1994–1997 and 2.9/100,000 for 1998–2001 (Figure 8).

[¶] Available at http://www.bls.gov/lau/staa_7000.pdf.

FIGURE 1. States reporting to the Adult Blood Lead Epidemiology and Surveillance (ABLES) program for ≥2 years — United States, 1998–2001

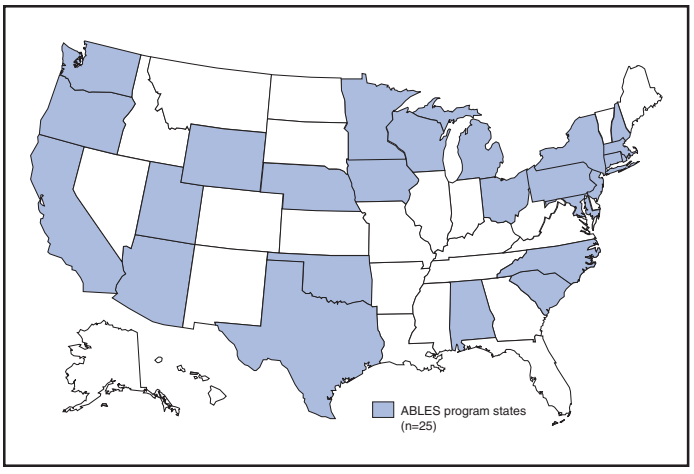


TABLE 1. Adults with blood lead levels ≥25 µg/dL reported to the Adult Blood Lead Epidemiology and Surveillance (ABLES) program during 1994–2001 by 25 states

State	1994	1995	1996	1997	1998	1999	2000	2001
Alabama	502	NA*	511	567	549	490	634	578
Arizona	40	148	56	79	91	48	58	35
California	1,347	997	1,010	1,044	900	911	1,001	872
Connecticut	354	262	229	207	118	124	99	77
Iowa	NA	533	522	421	309	401	268	432
Maryland	196	178	153	189	162	292	229	205
Massachusetts	755	641	582	507	470	429	368	297
Michigan	NA	NA	NA	136	303	273	235	208
Minnesota	NA	467	255	258	264	272	190	244
Nebraska	NA	NA	NA	NA	NA	143	94	NA
New Hampshire	NA	NA	NA	187	213	174	212	142
New Jersey	744	611	592	567	511	534	572	543
New York	955	850	1,115	1,045	903	948	955	834
North Carolina	224	342	269	362	379	426	475	558
Ohio	NA	NA	1,367	1,440	1,146	1,090	1,039	1,572
Oklahoma	52	76	94	88	67	46	66	49
Oregon	269	199	204	187	129	170	180	89
Pennsylvania	2,005	2,897	2,862	3,348	2,394	2,031	2,826	2,113
Rhode Island	NA	NA	NA	104	78	67	178	95
South Carolina	367	595	188	189	195	32	60	NA
Texas	387	189	738	687	556	510	554	307
Utah	83	102	57	98	75	41	34	45
Washington	232	241	203	277	152	148	160	120
Wisconsin	713	932	600	528	428	671	738	507
Wyoming	NA	NA	NA	99	67	39	47	21
Total	**9,225**	**10,260**	**11,607**	**12,614**	**10,459**	**10,310**	**11,272**	**9,943**

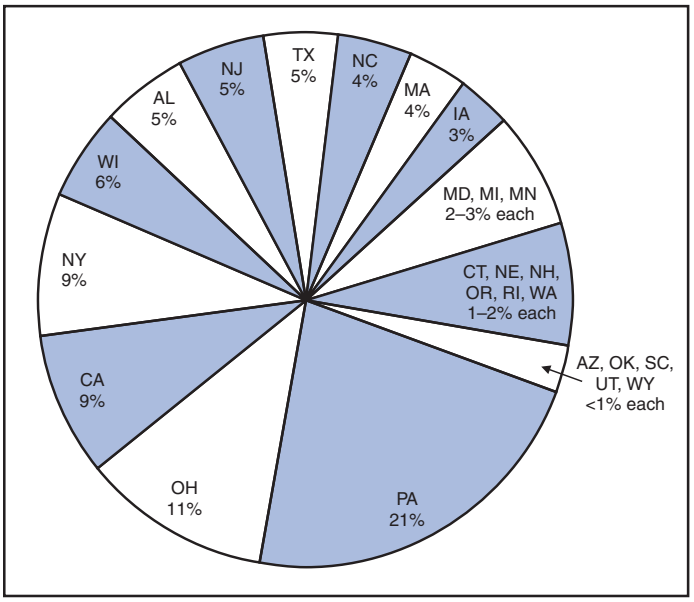
* NA = Not available.

TABLE 2. Adults with blood lead levels ≥40 µg/dL reported to the Adult Blood Lead Epidemiology and Surveillance (ABLES) program during 1994–2001 by 25 states

State	1994	1995	1996	1997	1998	1999	2000	2001
Alabama	180	NA*	165	165	142	144	221	217
Arizona	9	39	19	23	16	2	9	8
California	232	196	167	142	150	126	149	134
Connecticut	85	38	29	46	26	21	20	18
Iowa	NA	99	100	68	24	37	19	41
Maryland	61	41	39	47	33	77	54	32
Massachusetts	189	158	122	115	99	80	71	49
Michigan	NA	NA	NA	25	72	48	48	36
Minnesota	NA	120	92	64	54	48	39	56
Nebraska	NA	NA	NA	NA	NA	21	12	NA
New Hampshire	NA	NA	NA	48	66	45	53	32
New Jersey	183	121	127	120	116	104	119	113
New York	164	136	230	208	199	205	178	141
North Carolina	137	181	139	207	188	191	289	386
Ohio	NA	NA	414	384	222	257	304	318
Oklahoma	15	26	35	35	23	18	17	17
Oregon	49	26	38	28	13	27	38	8
Pennsylvania	NA	NA	506	482	294	242	325	222
Rhode Island	NA	NA	NA	26	24	17	44	25
South Carolina	290	485	94	101	85	4	16	NA
Texas	306	127	163	147	109	111	111	64
Utah	19	18	11	19	16	4	5	14
Washington	75	57	58	65	22	29	38	18
Wisconsin	125	156	95	67	49	68	71	55
Wyoming	NA	NA	NA	36	29	7	2	5
Total	**2,119**	**2,024**	**2,643**	**2,668**	**2,071**	**1,933**	**2,252**	**2,009**

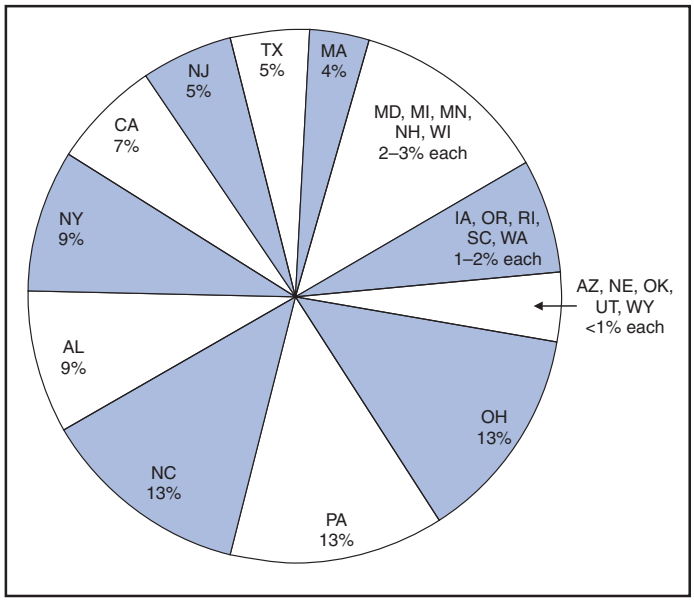
* NA = Not available.

FIGURE 2. Mean annual percentages by state of total adults with blood lead levels ≥25 µg/dL as reported by 25 ABLES program states, 1998–2001*



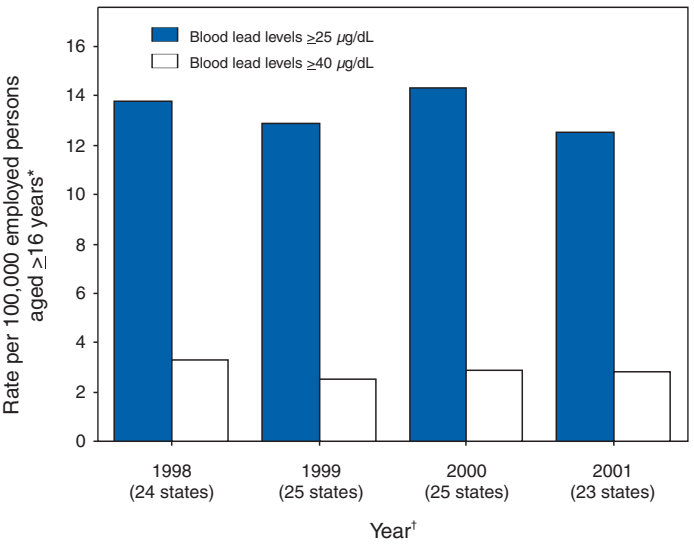
* Nebraska, 2 years of data; South Carolina, 3 years of data.

FIGURE 3. Mean annual percentages by state of total adults with blood lead levels ≥40 µg/dL as reported by 25 ABLES program states, 1998–2001*



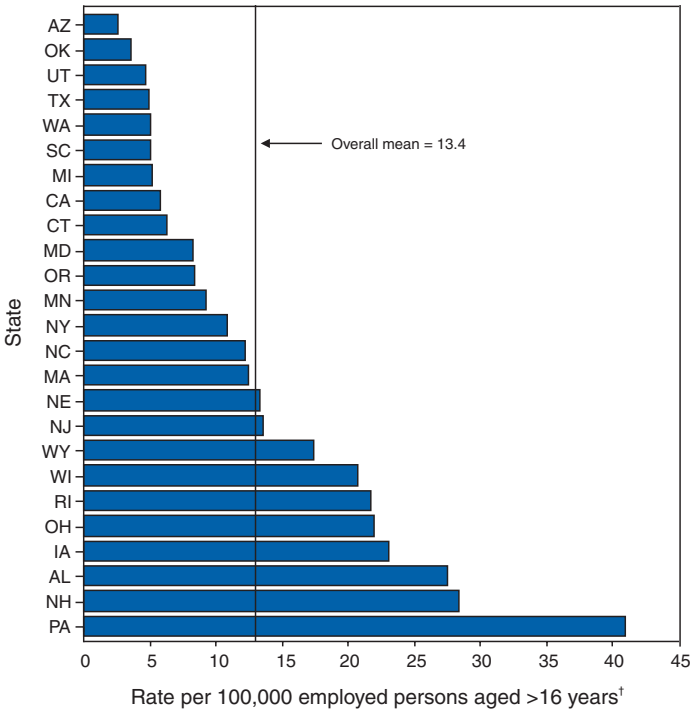
* Nebraska 2 years of data, South Carolina 3 years of data.

FIGURE 4. Mean annual state rates of adults with elevated blood lead levels, as reported by 25 ABLES program states, 1998–2001



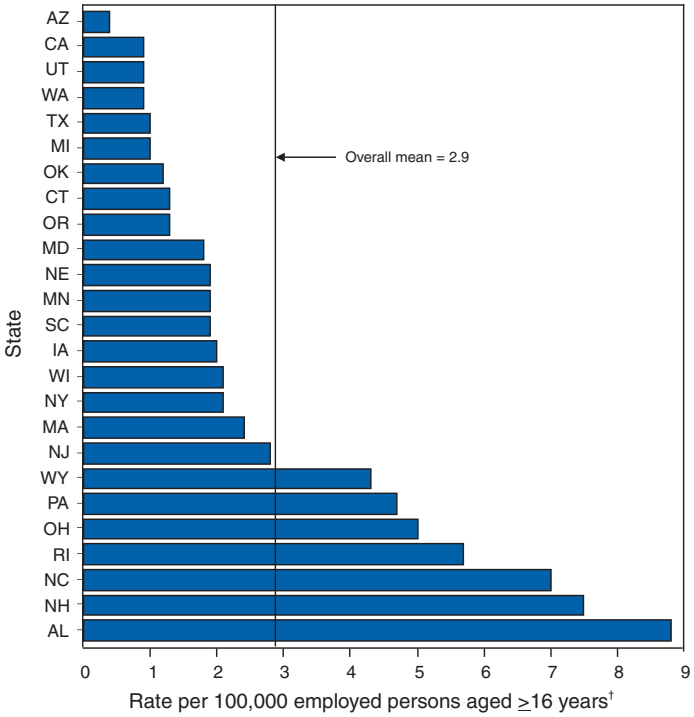
* **Source:** Bureau of Labor Statistics, Current Population Survey, 2001.
† Nebraska, 1999–2000 only; South Carolina, 2000 only.

FIGURE 5. Mean annual rate by state of adults with blood lead levels ≥25 µg/dL reported by 25 ABLES program states, 1998–2001



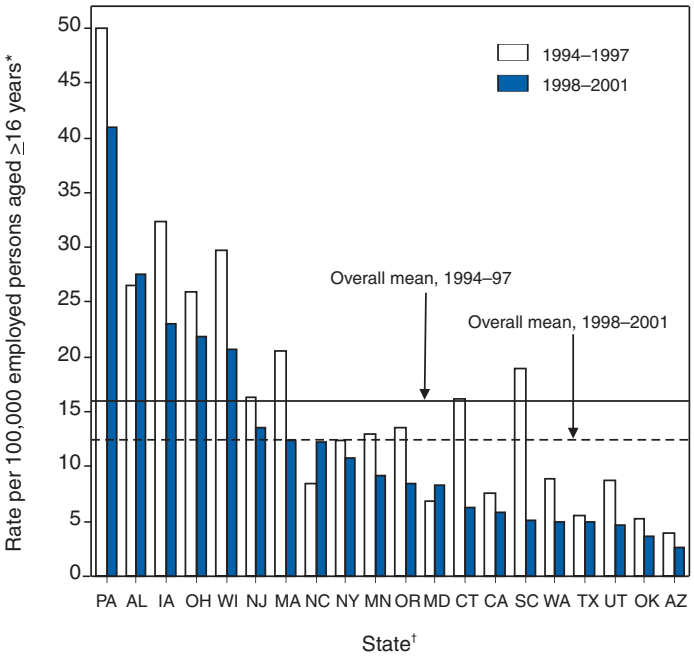
* Nebraska 2 years of data; South Carolina 3 years of data.
† **Source:** Bureau of Labor Statistics, Current Population Survey, 2001.

FIGURE 6. Mean annual rate by state of adults with blood lead levels ≥40 µg/dL reported by 25 ABLES program states, 1998–2001



*Nebraska, 2 years of data; South Carolina, 3 years of data.
†**Source:** Bureau of Labor Statistics, Current Population Survey, 2001.

FIGURE 7. Mean annual rates by state, 1998–2001 compared with 1994–1997, for adults with blood lead levels ≥25 µg/dL — 20 ABLES program states reporting data for ≥2 years in each period



*†**Source:** Bureau of Labor Statistics, Current Population Survey, 2001.
†South Carolina, 3 years of data (1998–2001); Ohio, 2 years of data; Alabama, Iowa, and Minnesota, 3 years of data (1994–1997).

To better illustrate the decline in BLL rates, the mean annual rates for the overall program are presented for the years 1994–1997 (Figure 9). From 1998 onward, with the exception of 2000, the rates for adults with BLLs ≥25 µg/dL decreased to <14/100,000. Likewise, the rates for adults with BLLs ≥40 µg/dL decreased to <3/100,000.

CDC/NIOSH funding has enabled surveillance and intervention activities among ABLES states that have contributed to the decline in adult BLLs. NIOSH increased its funding commitment, allowing the ABLES program to expand from 21 to 35 funded states for 2002 (Figure 10). Four of these additional 14 states were already providing data to ABLES (California, Nebraska, New Hampshire, and Utah); three resumed reporting (Illinois, Maine, and New Mexico); and seven were completely new (Florida, Georgia, Hawaii, Kansas, Kentucky, Missouri, and Montana).

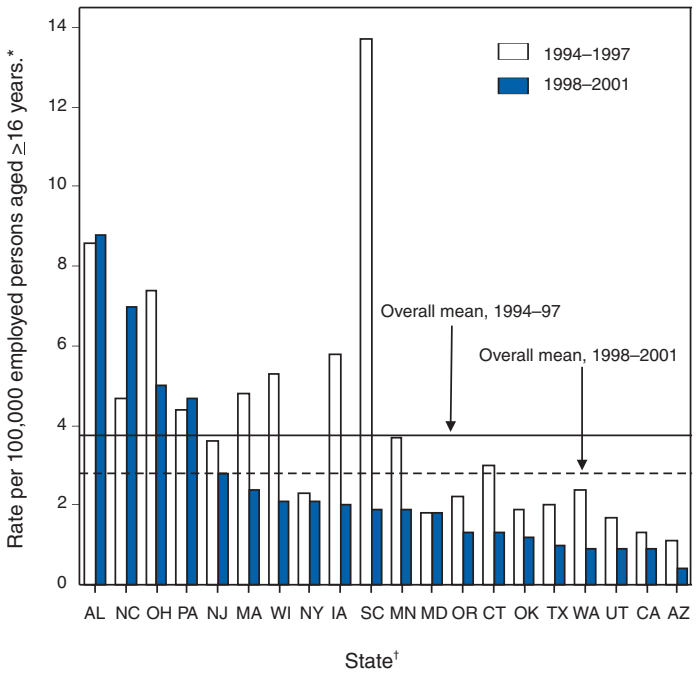
Discussion

This data analysis has certain limitations, including the numerators and denominators used in calculating the prevalence rates. The numerators are the numbers of adults with BLLs ≥25 or ≥40 µg/dL, as reported by the ABLES states. These numbers are likely underreported because 1) not all employers provide BLL testing to lead-exposed workers; and 2) to a lesser extent, certain laboratories might not be in compliance with reporting requirements. Additionally, certain states with workers at risk do not participate.

The denominators are the numbers of persons, aged ≥16 years, who were employed in the state during the year in question. An advantage of using the employed population as the denominator is that it excludes unemployed adults who have limited risk for lead exposure. A disadvantage of using the employed population is that the numbers include those whose jobs do not involve lead exposures.

State-to-state comparisons have been made in this report by using the data reported from the states to the ABLES program. Questions regarding the specifics of any state's reporting should be addressed to the ABLES contact from that state (state contacts are available at the ABLES website). Certain states publish in-depth analyses of their surveillance data, and these analyses provide the most complete descriptions (*13–14,25–26*).

FIGURE 8. Mean annual rates by state, 1998–2001 compared with 1994–1997, for adults with blood lead levels ≥40 µg/dL — 20 ABLES program states reporting data for ≥2 years in each period



* **Source:** Bureau of Labor Statistics, Current Population Survey, 2001.
† (1998–2001) South Carolina 3 years of data; (1994–1997) Ohio and Pennsylvania 2 years of data; Alabama, Iowa, and Minnesota, 3 years of data.

FIGURE 10. States funded for ABLES program by CDC/ National Institute for Occupational Safety and Health — United States, 2002

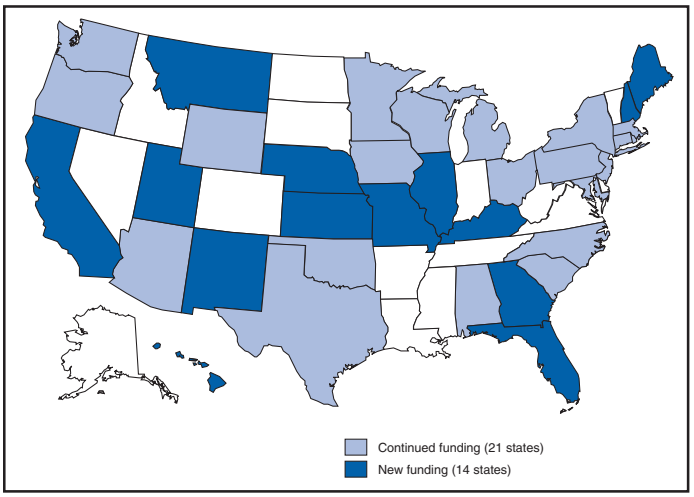
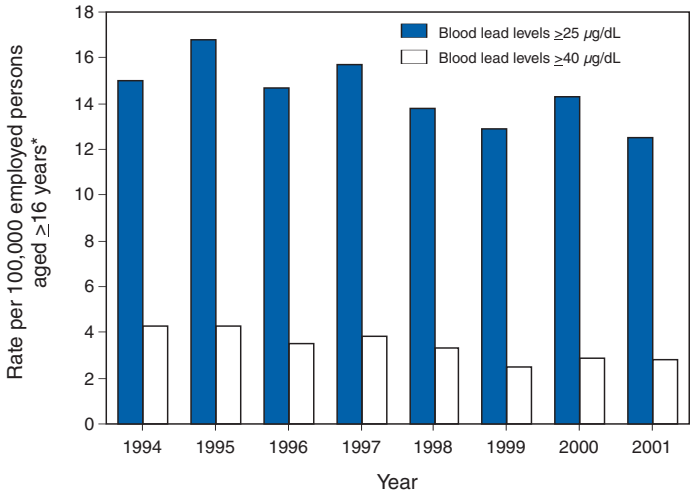


FIGURE 9. Mean annual state rates of adults with elevated blood lead levels, as reported by ABLES program states, 1994–2001



* **Source:** Bureau of Labor Statistics, Current Population Survey, 2001.

The decline in BLL rates observed in this analysis depends on continued, effective intervention and prevention efforts by ABLES program participants and their partners. For example,

- In California, high efficiency particulate air-exhausted power-sanding reduced paint dust exposure by approximately 80%–90% (*18*). Also, contractors and their employees can now make moderate improvements in lead safety practices if provided extensive training and technical assistance (*19*).
- In Michigan, follow up of companies identified with at least one worker with a BLL of 30–39 µg/dL was determined to be an effective method for targeting inspections, leading Michigan OSHA to follow up on all BLLs >25 µg/dL (*20*).
- In Washington, potentially exposed workers were identified through hazard surveillance and characterization of workplace knowledge and practices (through survey and registry), allowing targeting of resources toward industries most in need (*27*).

CDC/NIOSH continues to take steps to improve the ABLES program. In addition to expanding the program from 21 to 35 states, NIOSH stipulated that future ABLES data would be collected on an individual rather than aggregate basis. These individual data, providing information specific to occupation, industry, sex, and age, will be more useful to the efforts to reduce BLLs. With NIOSH assistance, persons from certain ABLES states are also developing clinical/laboratory guidelines that will help improve identification of lead

exposure and treatment by medical personnel of this often unrecognized and misunderstood public health problem (*11*). At the same time, CDC is working to implement greater standardization and efficiency for all its surveillance programs, including ABLES, under the National Electronic Disease Surveillance System.**

Other partners in the effort to reduce BLLs include the following:

- OSHA's National Emphasis Program to reduce occupational lead exposures;††
- voluntary lead-reducing initiatives by trade associations (e.g., Lead Industries Association Incorporated and Battery Council International);
- lead research and training programs for the construction industry offered by the Center to Protect Workers' Rights;§§ and
- lead initiatives taken by CSTE. In addition to collaborating with ABLES in developing the case definition for elevated BLLs among adults (*17*), CSTE also adopted the position that ABLES be designated the initial core component of state-based occupational health and safety surveillance (*34*), and coordinated development with ABLES of the CSTE occupational health surveillance indicator for lead (*35*). CSTE advocates that these occupational health surveillance indicators be collected in all 50 states and U.S. territories. CSTE has also called for a tightening of OSHA's lead standards (*36*).

Despite limitations and variations within the ABLES program, data indicate a declining trend in the number of adults with elevated BLLs. Because the program has increased in size and with the addition of more detailed reporting requirements, ABLES has increased its capability to offer data, intervention insights, and other assistance as it works toward its *Healthy People 2010* target of eliminating work-related BLLs ≥25 µg/dL among all adults by 2010 (*10*).

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** Available at http://www.cdc.gov/programs/research12.htm.
†† Available at http://www.osha-slc.gov/SLTC/lead/index.html.
§§ Available at http://www.cpwr.com.

References

1. Sussell A, Ashley K, Burr G, et al. Protecting workers exposed to lead-based paint hazards: a report to Congress. Rockville, MD: US Department of Health and Human Services, National Institute for Occupational Safety and Health. DHHS publication no. (NIOSH) 98–112, 1997.
2. Agency for Toxic Substances and Disease Registry. Toxicological profile for lead. Atlanta, GA. U.S. Department of Health and Human Services, Public Health Service, 1999.
3. Agency for Toxic Substances and Disease Registry. Case studies in environmental medicine: lead toxicity. Revised. U.S. Department of Health and Human Services, Public Health Service, 2000. Available at http://www.atsdr.cdc.gov/HSPH/caselead.html.
4. Kosnett MJ. Lead. In: Olson, KR, ed. Poisoning and drug overdose: a Lange clinical manual. 2nd ed. Norwalk, CT: Appleton and Lange, 1994:196–200.
5. Mantere P, Hanninen H, Hernberg S, Luukkonen R. A prospective follow-up study on psychological effects in workers exposed to low levels of lead. Scand J Work Environ Health 1984;10:43–50.
6. Schwartz J. Lead, blood pressure, and cardiovascular disease in men. Arch Environ Health 1995;50:31–7.
7. Hu H, Aro A, Payton M, et al. The relationship of bone and blood lead to hypertension. JAMA 1996;275:1171–6.
8. Torres-Sanchez LE, Berkowitz G, Lopez-Carrillo L, Torres-Arreola L, Rios C, Lopez-Cervantes M. Intrauterine lead exposure and preterm birth. Environ Res 1999;81:297–301.
9. Borja-Aburto VH, Hertz-Picciotto I, Rojas Lopez M, Farias P, Rios C, Blanco J. Blood lead levels measured prospectively and the risk of spontaneous abortion. Am J Epidemiol 1999;50:590–7.
10. U.S. Department of Health and Human Services. Healthy people 2010. 2nd ed. Washington, DC: U.S. Government Printing Office, 2000. Available at http://www.health.gov/healthypeople.
11. Ottlinger M, Zumwalde R, Roscoe R, et al. Adult blood lead testing: a pivotal role for labs in interpretation and surveillance. Clinical Laboratory News 2002 June;12–14.
12. American Conference of Governmental Industrial Hygienists. 2001 TLVs® and BEIs®: threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: ACGIH, 2001.
13. Occupational Health Branch, California Department of Health Services. Blood lead levels in California workers, 1995–1999. California Department of Health Services, 2002.
14. Division of Epidemiology, Environmental and Occupational Health, New Jersey Department of Health and Senior Services. Update: special issue on lead, 2002 April.
15. Pirkle JL, Kaufmann RB, Brody DJ, Hickman T, Gunter EW, Paschal DC. Exposure of the U.S. population to lead, 1991–1994. Environ Health Perspect 1998;106:745–50.
16. Pirkle JL, Brody DJ, Gunter EW, et al. The decline in blood lead levels in the United States. JAMA 1994;272:284–91.
17. Stanbury M. and Roscoe RJ. Surveillance case definition for adult blood lead levels to be reported to the National Public Health Surveillance System. Council of State and Territorial Epidemiologists (CSTE) position statement 99–ENV–2, 1999. Available at http://www.cste.org/ps/1999/1999-env-02.htm.
18. Scholz PF, Materna BL, Harrington D, Uratsu C. Residential and commercial painters' exposure to lead during surface preparation. Am Ind Hyg Assoc J 2002;63:22–8.

19. Materna BL, Harrington D, Scholz P, et al. Results of an intervention to improve lead safety among painting contractors and their employees. Am J Ind Med 2002; 41:119–30.
20. Rosenman KD, Sims, A, Hogan A, Fialkowski J, Gardiner J. Evaluation of the effectiveness of following up laboratory reports of elevated blood leads in adults. Am Ind Hyg Assoc J 2001;62:371–8.
21. Materna B. Occupational and take-home lead poisoning associated with restoring chemically stripped furniture—California, 1998. MMWR 2001;50:246–8.
22. Vork KL, Hammond SK, Sparer J, Cullen MR. Prevention of lead poisoning in construction workers: a new public health approach. Am J Ind Med 2001;39:243–53.
23. Roscoe RJ, Gittleman JL, Deddens JA, Petersen MR, Halperin WE. Blood lead levels among the children of lead-exposed workers: a meta-analysis. Am J Ind Med 1999;36:475–81.
24. Reh BD. Health hazard evaluations: issues related to occupational exposure to lead 1994 to 1999. Rockville, MD: US Department of Health and Human Services, National Institute for Occupational Safety and Health. DHHS publication no. (NIOSH) 2001–113, 2001.
25. Tumpowsky CM, Davis LK, Rabin R. Elevated blood lead levels among adults in Massachusetts, 1991–1995. Public Health Rep 2000;115:364–9.
26. Roche LM, Ramaprasad R, Gerwel B, et al. Evolution of a state occupational lead exposure registry: 1986–1996. J Occup Environ Med 1998;40:1127–33.
27. Nelson NA, Kaufman JD. Employees exposed to lead in Washington state nonconstruction workplaces: a starting point for hazard surveillance. Am Ind Hyg Assoc J 1998;59:269–77.
28. CDC. Adult blood lead epidemiology and surveillance—United States, second and third quarters, 1998, and annual 1994–97. MMWR 1999;48:213–6, 223.
29. Stanton NV. Erythrocyte protoporphyrin. Therapeutic Drug Monitoring and Toxicology 2000;21:305–14.
30. US Department of Labor, Occupational Safety and Health Administration. Final standard; occupational exposure to lead. Federal Register 1978;43:52952–3014 [29 CFR § 1910.1025].
31. US Department of Labor, Occupational Safety and Health Administration. Lead exposure in construction—interim rule. Federal Register 1993;58:26590–26649 [29 CFR § 1926.62].
32. Hipkins KL, Materna BL, Kosnett MJ, Rogge JW, Cone JE. Medical surveillance of the lead exposed worker: current guidelines. AAOHN J 1998;46:330–9.
33. US Department of Labor, Bureau of Labor Statistics. Annual average estimates from the current population survey. Available at http://www.bls.gov/lau/staa_7000.pdf.
34. Davis L. Designation of adult blood lead epidemiology and surveillance as the initial core component of state-based occupational health and safety surveillance. Council of State and Territorial Epidemiologists (CSTE) position statement 00–OCC–01, 2000. Available at http://www.cste.org/ps/2000/2000-occ-01.htm.
35. Ball W, Calvert G, Castellan R, et al. Occupational health surveillance indicators for tracking work-related health effects and their determinants. Council of State and Territorial Epidemiologists (CSTE), 2002.
36. Materna B. Improved protection for lead-exposed workers: updating the OSHA lead standards for general industry and construction. Council of State and Territorial Epidemiologists (CSTE) position statement, 01–OCC–01, 2001. Available at http://www.cste.org/ps/2001/2001-occ-01.htm.

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