ADULT BLOOD LEAD LEVELS IN NEBRASKA, 2008–2012

Nebraska Occupational Safety and Health Surveillance Program

December 2014

Adult Blood Lead Levels in Nebraska, 2008–2012

Acknowledgements

We acknowledge Doug Gillespie and Jeremy Poell for their helpful review of the report. Appreciation is also extended to Xuan Li, Kathleen Pittack, and Eric Kingery for providing technical assistance with data. We also thank the Oregon Health Authority's Occupational Public Health Program for providing information and allowing use of the format used in this report.

This report was supported by Grant Number 5U600OH09859 from CDC–NIOSH. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of CDC–NIOSH.

Report prepared by

Derry Stover, MPH
Epidemiology Surveillance Coordinator

For more information, contact

Nebraska Department of Health and Human Services
Occupational Safety and Health Surveillance Program
301 Centennial Mall South, 3rd Floor
PO Box 95026
Lincoln, NE 68509

Phone: 402-471-2937
Fax: 402-471-3601
Website: http://dhhs.ne.gov/publichealth/occhealth/

List of terms and abbreviations used in this report

ABLES: Adult Blood Lead Epidemiology and Surveillance
BLL: Blood lead level
CDC: Centers for Disease Control and Prevention
NDHHS: Nebraska Department of Health and Human Services
NIOSH: National Institute for Occupational Safety and Health
OSHA: U.S. Occupational Safety and Health Administration
µg/dL: micrograms per deciliter

Executive Summary

Lead exposures are a public health problem in Nebraska. Serious health effects are known to occur in adults with very high blood lead levels, and recent research shows adverse health outcomes can occur with even low levels of lead in the blood. While lead can be found in several different environments, lead exposures in adults are usually work-related. Nebraska aims to meet the Healthy People 2020 objective to reduce the proportion of individuals who have elevated blood lead levels from work exposures.

In Nebraska, all tests that measure blood lead concentrations are required to be reported to Nebraska Department of Health and Human Services (NDHHS). Adult blood lead tests are tracked through the Nebraska Adult Blood Lead Epidemiology and Surveillance (ABLES) Program, a collaborative effort of the Lead-Based Paint Program and the Occupational Safety and Health Surveillance Program.

The following report summarizes blood lead tests in adults aged 16 years or older from 2008 to 2012. A total of 805 adults had an elevated blood lead level (BLL) ≥ 10 micrograms per deciliter (µg/dL), and 368 cases were among newly identified adults. New cases occurred most frequently among males and among adults 25 to 34 years old. Information such as work-relatedness and industry were not available for the majority of cases and are not shown in this report.

From 2008 to 2012, the overall average prevalence rate of elevated BLLs ≥ 10 µg/dL was 16.8 cases per 100,000 employed persons. The five-year average incidence rate of new cases with elevated BLLs ≥ 10 µg/dL was 7.7 cases per 100,000 employed persons.

Surveillance of blood lead levels allows Nebraska to track progress of meeting the Healthy People 2020 goal in reducing the proportion of individuals who have elevated BLLs. Improving data collection and enhancing surveillance efforts will help identify high-risk populations and characterize risk factors of lead exposed adults. Ultimately, surveillance of blood lead levels can be used to prioritize public health prevention and intervention efforts in order to reduce lead exposures among adults in Nebraska.

Introduction

Lead is a naturally-occurring, toxic metal used in a variety of products and industrial processes. Exposures to lead can result in elevated blood lead levels, which is a serious health problem. Over the last several decades, reduction of lead in the environment has lowered the risk of exposure. However, lead is still used in many industries and can be found in many work and home environments. No amount of lead in the body is considered safe, and even low levels of lead in the body can negatively impact a person's health.

In 2009, 7,122 individuals aged 16 years and older in 40 states conducting adult blood lead surveillance had an elevated blood lead level (BLL) greater than or equal to 10 micrograms per deciliter (µg/dL) [1]. The geometric mean of BLLs among adults in the United States was 1.2 µg/dL during 2009–2010 [2]. According to Healthy People 2020 objective OSH-7, the public health goal of reducing elevated blood lead levels is to reduce the proportion of persons who have elevated blood lead concentrations from work exposures [3]. The U.S. Department of Health and Human Services recommends that BLLs among all adults be reduced to below 10 µg/dL [4].

Health Effects of Lead

Lead exposures usually occur when lead, or dust and fumes containing lead, are breathed in or ingested. Lead exposures can occur from contamination of hands, food, water, cigarettes, and clothing. Once it enters the blood stream, lead can be stored in organs and bones where it can cause permanent damage. Both short-term exposures (lead exposures < 1 year) and long-term exposures (lead exposures ≥ 1 year) can result in adverse health effects.

When lead is absorbed into the body, it can adversely affect multiple organ systems and can damage the kidneys, brain, cardiovascular, and reproductive systems. Acute, high-dose exposures (≥ 40 µg/dL) can result in increased risk of neurocognitive deficits, anemia, neuropathy, sperm abnormalities, and non-specific symptoms such as headache, fatigue, sleep disturbance, anorexia, constipation, myalgia, and decreased libido [5].

Lead can affect the body even at low levels of exposures once thought to be harmless. Research has found possible increased risk of kidney dysfunction, high blood pressure, and essential tremor at BLLs of 10 µg/dL. Possible increased risks of postnatal developmental delay, spontaneous abortion, and reduced birth weight have also been shown in pregnant women with BLLs between 5–10 µg/dL [5] [6] [7].

Occupational lead exposures

Elevated lead levels in adults are commonly due to exposures in the workplace. Lead is used in a variety of industries, such as mining, manufacturing, and construction. Workers who are employed in certain industries or perform certain jobs are at a higher risk for lead exposures. Examples of these high-risk industries and occupations are listed in Table 1. Workers can also bring lead home with them from the job site, and this 'take home lead' can result in exposures to children and other family members.

Non-occupational lead exposures

Non-occupational exposures to lead can also occur (Table 2). Adults can be exposed to lead from certain hobbies like target shooting, car or boat repair, and furniture refinishing.

Lead-based paint has also been associated with lead exposures. Lead-based paint was widely used in homes until the 1950s and was not banned from residential use until 1978. Lead-based paint is still found in many older homes today and can be found on indoor and outdoor surfaces like windowsills, porches, walls, and siding. Lead exposures can occur when lead-based paint is disturbed during maintenance, renovation, or remodeling activities.

Lead has also been found in certain traditional and folk medicines, such as some Ayurvedic medicines, Daw Tway, Bhasma, Smrti, Ba-baw-san, Ghasard, Greta, and Azarcon. In addition to folk medicines, lead contamination can be associated with water and plumbing, imported candies, pottery, and dishware.

Table 1. Jobs and industries with potential lead exposures
Brass, bronze, copper, or lead foundries
Ammunition/explosives production
Scrap metal handling
Machining or grinding lead alloys
Renovation, repair of structures with lead paint
Welding or torch-cutting painted metal
Sandblasting, sanding, scraping, or disturbing lead paint
Battery manufacturing or recycling
Firing ranges
Automotive repair

Table 2. Non-occupational sources of lead exposure
Recreational target shooting
Remodeling/renovation of pre-1978 housing
Folk remedies (e.g., azarcon, some Ayurvedics)
Melting lead for bullets, fishing weights, or toys
Car or boat repair
Cosmetics (e.g., kohl eye makeup)
Furniture refinishing
Making stained glass or jewelry
Soldering or welding
Lead-glazed tableware or cooking vessels
Glazing/pottery making

Adult Blood Lead Level Surveillance

Program Description

The Nebraska Department of Health and Human Services (NDHHS) conducts public health surveillance on diseases, conditions, and poisonings that are of public health significance. Public health surveillance is defined as the ongoing, systematic collection, analysis, interpretation, and dissemination of data regarding a health-related event for use in public health action to reduce morbidity and mortality and to improve health [8].

In 2012, NDHHS was among approximately 40 states participating in the Adult Blood Lead Epidemiology and Surveillance (ABLES) Program, which was administered by the Centers for Disease Control and Prevention (CDC) National Institute for Occupational Safety and Health (NIOSH). The Nebraska ABLES Program is a collaboration of the NDHHS Lead-Based Paint and Occupational Safety and Health Surveillance Programs. The ABLES Program conducts data entry, case notification, case follow-up, and provides educational and technical assistance for individuals, local health departments, and health care providers.

Data collection

Nebraska's Communicable Diseases Regulations (173 NAC 1) require all blood lead tests to be reported to NDHHS by health care providers and laboratories [9]. The regulation also requires the date of sample collection and analysis, whether the sample is a capillary or venous blood sample, the date of birth, address, and sex of the individual, the name and address of the physician, and the race and ethnicity of the patient, if known. Blood lead laboratory tests are entered into Nebraska's Electronic Disease Surveillance System (NEDSS) either by electronic laboratory reporting or manual data entry.

Case definition

An elevated BLL is defined as an adult aged 16 years or older with a BLL ≥ 10 µg/dL [10]. For this report, a BLL ≥ 40 µg/dL is described as a very high BLL. An incident (new) case is an adult with an elevated BLL reported in the calendar year but not reported in the immediately preceding year.

Methodology

Records of blood lead laboratory tests conducted between 2008 and 2012 among adults aged 16 years or older were cleaned and unduplicated. The numbers of blood lead tests entered into the surveillance system each year are reported, as well as the number of adults with a BLL using an individual's highest BLL in a given year. The number and percent of total cases were analyzed by year and BLL, and the number and percent of new (incident) cases were analyzed by year, BLL, sex, and race when known.

Prevalence and incidence rates were calculated based on the number of cases per 100,000 employed persons indicated in employment data from the Bureau of Labor Statistics Current Population Survey. Average annual incidence rates by county of residence were also calculated and mapped.

Results

From 2008 to 2012, a total of 8,958 blood lead tests among adults aged 16 years or older were entered into the surveillance system, which represented a total of 7,645 adults with a BLL (Table 3). Over the five year period, the total number of BLLs and the number of adults with a blood lead test generally declined.

Table 3. Number of blood lead tests among adults, by year, Nebraska, 2008–2012

Year	Number of BLLs	Number of adults with a BLL
2008	2,078	1,802
2009	1,853	1,608
2010	1,926	1,577
2011	1,629	1,290
2012	1,472	1,188
Total	**8,958**	**7,465**

Out of the 7,465 adults with a BLL from 2008 to 2012, a total of 805 (10.8%) had an elevated BLL ≥ 10µg/dL. Of the adults with elevated BLLs, 583 (72.4%) were 10–24 µg/dL, 185 (23.0%) were 25–39 µg/dL, and 37 (4.6%) were ≥ 40 µg/dL (Table 4).

Table 4. Number of adults with an elevated BLL, Nebraska, 2008–2012

Year	10–24 µg/dL		25–39 µg/dL		≥ 40 µg/dL		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
2008	155	76.7	35	17.3	12	5.9	202	100.0
2009	99	69.2	36	25.2	8	5.6	143	100.0
2010	110	70.5	39	25.0	7	4.5	156	100.0
2011	103	74.1	31	22.3	5	3.6	139	100.0
2012	116	70.3	44	26.7	5	3.0	165	100.0
Total	**583**	**72.4**	**185**	**23.0**	**37**	**4.6**	**805**	**100.0**

Table 5 shows the number and percent of newly-identified adults (incident cases) with an elevated BLL by year and by lead level. Overall, 368 new adults had an elevated BLL ≥ 10µg/dL from 2008 to 2012. The number of new adults with an elevated BLL was highest in 2008 and in 2012.

Table 5. Number of new adults with an elevated BLL, Nebraska, 2008–2012

Year	10–24 µg/dL		25–39 µg/dL		≥ 40 µg/dL		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
2008	79	86.8	8	8.8	4	4.4	91	100.0
2009	39	70.9	10	18.2	6	10.9	55	100.0
2010	62	80.5	13	16.9	2	2.6	77	100.0
2011	52	83.9	8	12.9	2	3.2	62	100.0
2012	62	74.7	18	21.7	3	3.6	83	100.0
Total	**294**	**79.9**	**57**	**15.5**	**17**	**4.6**	**368**	**100.0**

Table 6 shows the number and percent of new adults with an elevated BLL by demographic characteristics such as sex, age group, and race/ethnicity if known. Among the 368 adults with BLLs ≥ 10 µg/dL, 91.6% were male, 29.9% were 25 to 34 years old. Individuals of white race/ethnicity made up 48.9% of total cases. However, race/ethnicity was unknown in more than 40% of cases. While the proportion of BLLs 10–24 µg/dL was highest in the 25 to 34 years old age group (32.0%), the proportion of very high BLLs ≥ 40 µg/dL was highest in the 35 to 44 and 55 to 64 age groups (both 29.4%).

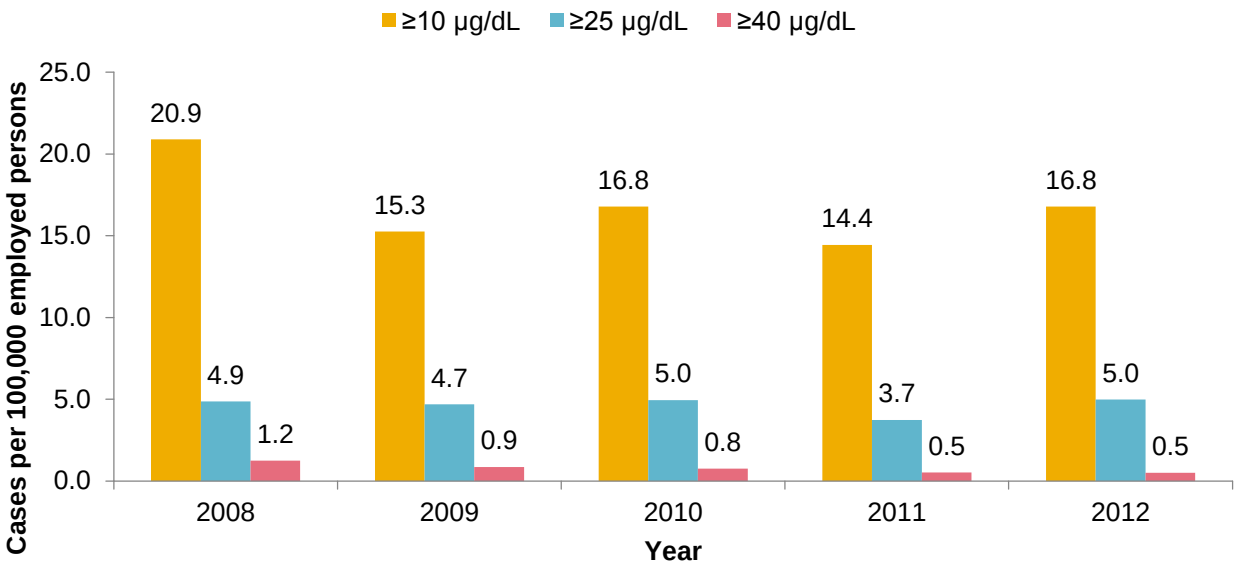
Table 6. Number of new adults with an elevated BLL by demographic characteristic and level, Nebraska, 2008–2012

Demographic characteristic	10–24 µg/dL		25–39 µg/dL		≥40 µg/dL		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total adults	294	79.9	57	15.5	17	4.6	368	100.0
Sex								
Male	272	92.5	49	86.0	16	94.1	337	91.6
Female	16	5.4	4	7.0	1	5.9	21	5.7
Unknown	6	2.0	4	7.0	0	0.0	10	2.7
Age Group								
16 to 24	38	12.9	9	15.8	2	11.8	49	13.3
25 to 34	94	32.0	16	28.1	0	0.0	110	29.9
35 to 44	63	21.4	6	10.5	5	29.4	74	20.1
45 to 54	49	16.7	10	17.5	4	23.5	63	17.1
55 to 64	38	12.9	9	15.8	5	29.4	52	14.1
65 and older	12	4.1	7	12.3	1	5.9	20	5.4
Race/Ethnicity								
White	145	49.3	29	50.9	6	35.3	180	48.9
Black	9	3.1	3	5.3	0	0.0	12	3.3
Hispanic	6	2.0	0	0.0	0	0.0	6	1.6
Asian	14	4.8	0	0.0	0	0.0	14	3.8
Other	5	1.7	1	1.8	1	5.9	7	1.9
Unknown	115	39.1	24	42.1	10	58.8	149	40.5

Measuring the rate of adults with elevated BLLs for multiple years identifies trends of lead exposures among Nebraskans. The prevalence of elevated BLLs includes all cases and describes the total burden of lead exposures among Nebraskans over time, while the incidence of elevated BLLs includes only newly identified cases and describes changes in the risk status of lead exposures.

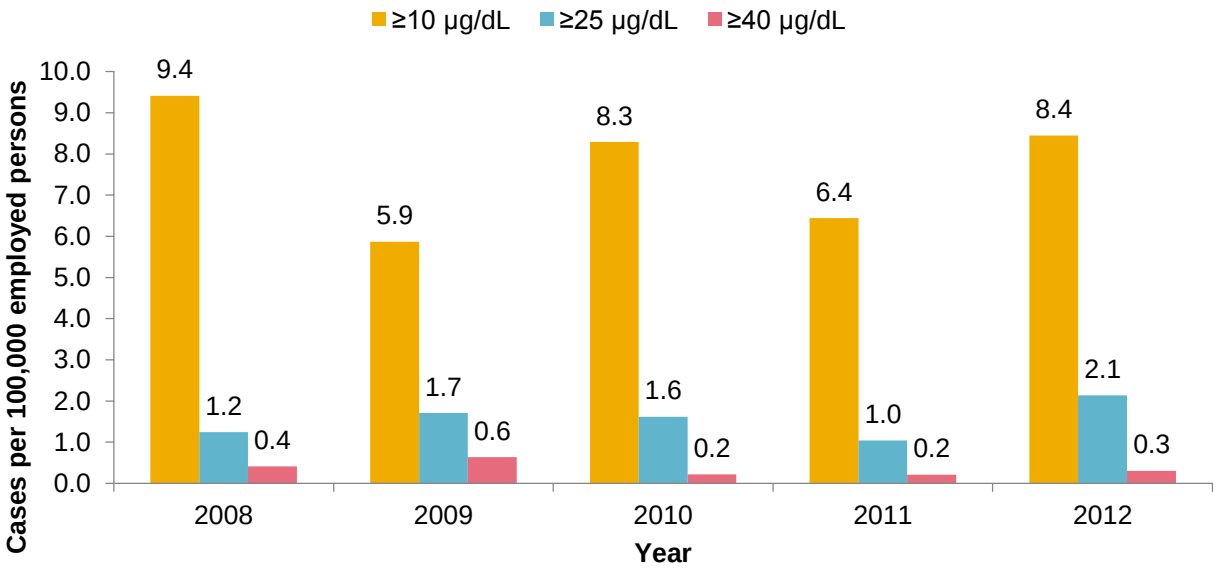
From 2008 to 2012, the average prevalence rate of elevated BLLs ≥ 10 µg/dL was 16.8 cases per 100,000 employed persons. The prevalence rate of elevated BLLs ≥ 10 µg/dL was lower in 2012 compared to 2008, although the rate increased during years 2009–2010 and 2011–2012. The prevalence rate of BLLs ≥ 25 µg/dL generally was relatively unchanged from 2008 to 2012 except for a decrease in 2011. Prevalence of BLLs ≥ 40 µg/dL decreased over the five year period (Figure 1).

Figure 1. Annual prevalence rates of adults with elevated BLLs, Nebraska, 2008–2012



The five-year average incidence rate of elevated BLLs ≥ 10 µg/dL was 7.7 cases per 100,000 employed persons. Similar to the prevalence rates, the incidence rate of BLLs ≥ 10 µg/dL was lower in 2012 compared to 2008, however rates increased between years 2009–2010 and 2011–2012. While the incidence rate of BLLs ≥ 25 µg/dL was showed variability, it was nearly twice as high in 2012 compared to 2008 (Figure 2).

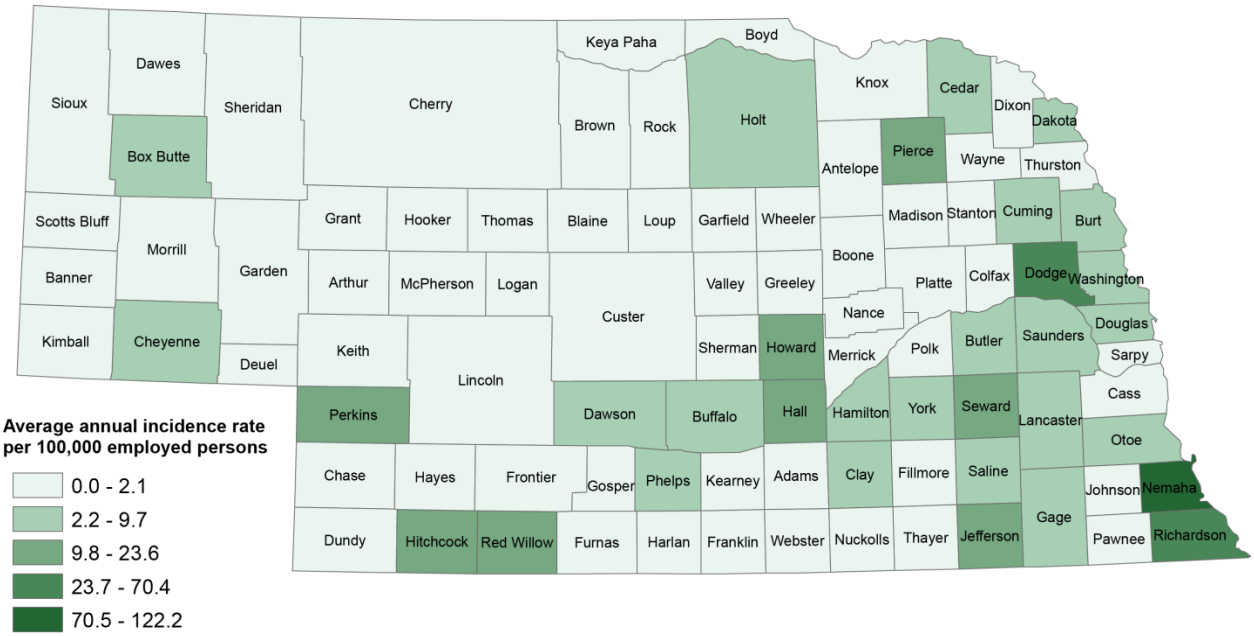
Figure 2. Annual incidence rates of adults with new elevated BLLs, Nebraska 2008–2012*



*An incident case is a case with an elevated BLL reported in the calendar year, but not reported in the immediately preceding year with an elevated BLL.

Average annual incidence rates of elevated BLLs ≥ 10 µg/dL from 2008 to 2012 were also calculated by the individual's county of residence. The map in Figure 3 shows the highest incidence rates were among adults living in southeastern Nebraska. The counties in Nebraska with the highest average incidence rates were Nemaha, Richardson, and Dodge.

Figure 3. Average annual incidence rates of elevated BLLs ≥ 10 µg/dL, by county, Nebraska, 2008–2012.



Discussion

Summary

Surveillance of blood lead levels among adults is important in meeting the Healthy People 2020 objective to reduce the number of persons who have elevated blood lead concentrations. The Nebraska ABLES program monitors and tracks BLLs in Nebraska, identifies new exposure sources and high-risk populations, and conducts educational and technical assistance with physicians, individuals, and local health departments.

Surveillance data show the total number of adults tested for lead decreased over time. In Nebraska, an elevated BLL case is defined as an adult age 16 years or older with a BLL ≥ 10 µg/dL. From 2008 to 2012, a total of 8,958 blood lead tests were entered into the surveillance system which represented 7,465 adults. A total of 805 adults had an elevated BLL, and 368 cases were among newly identified adults.

The majority of new elevated BLL cases occurred among males. While most new cases of elevated BLLs occurred among adults 25 to 34 years old, very high BLLs (≥ 40 µg/dL) occurred

more frequently in adults aged 35 to 44 and 55 to 64 years old. White individuals accounted for the majority of cases, however race or ethnicity are frequently not reported.

The average prevalence of Nebraska adults with BLLs ≥ 25 µg/dL was 6.3 per 100,000 employed persons from 2008–2012, which was lower than the U.S. prevalence of 6.3 per 100,000 employed persons in 2009 [1]. Nationally, prevalence rates of adults with BLLs ≥ 25 µg/dL have decreased in recent years. However, a decreasing trend was not observed in the prevalence and incidence rates of BLLs ≥ 25 µg/dL in Nebraska. Conversely, rates of very high BLLs (≥ 40 µg/dL) appear to be decreasing. According to average annual incidence rates of elevated BLLs, the highest incidence rates were among adults living in southeastern Nebraska.

Limitations

Adult lead testing data are subject to several limitations. Data do not characterize the entire burden of lead exposures in Nebraska, and the number of adults with elevated lead levels is likely underestimated. Not all employers provide blood lead testing, and many workers with significant occupational lead exposure are not appropriately tested.

Despite the requirement to report all blood lead tests in Nebraska, some laboratories might not report to Nebraska Department of Health and Human Services. Blood lead tests for residents of Nebraska might also not be reported to NDHHS if the test was conducted out of state. Adults exposed to lead in the home environment or due to certain hobbies are unlikely to be tested if they do not experience symptoms.

Rates of adults tested from 2008 to 2012 were based on the number of employed adults aged 16 years or older per the Bureau of Labor Statistics Current Population Survey. In the U.S., occupational exposures accounted for 91% of adults with BLLs ≥ 40 [12] from 2002 to 2011. Nebraska was unable to identify work-relatedness and source of exposure for the majority of cases. Therefore, it is possible that some adults with non-occupational lead exposures were included in the numerator. Information in terms of ethnicity, race, occupation, and source of lead exposures were unavailable for many tests, and the missing data create challenges in defining the risk for certain groups.

Despite limitations, surveillance of adult BLLs can be an important tool for identifying at risk populations and describing the status of lead exposures in adults. Surveillance data communicated to the occupational health and safety community can be used to prioritize intervention efforts and educate high-risk workers in Nebraska.

Recommendations

Despite reductions of lead in the environment in recent years, surveillance data show adults in Nebraska continue to be exposed to lead. Current workplace regulations for lead exposure prevention were established in the 1970s by the U.S. Occupational Safety and Health Administration (OSHA). OSHA standards require workers to be removed from lead exposure when whole-blood lead concentrations exceed 50 µg/dL (construction industry) or 60 µg/dL (general industry) and allow workers to return to work when the BLL is below 40 µg/dL. Despite

these regulations, recent studies highlight the health risks of BLLs below 10 µg/dL. Therefore, scientists and doctors recommend BLLs among adults should be reduced to below 10 µg/dL [5].

Medical surveillance helps identify lead exposures among workers. OSHA standards require workers to be included in a lead medical surveillance program if his/her airborne lead exposure is 30 $\mu g/m^3$ (eight-hour time-weighted average) or higher for more than 30 days per year. Given the concern regarding adverse health effects of lead associated with the lower levels of exposure, all lead-exposed workers should have a blood lead test. Updated medical management guidelines for adult lead exposures that reflect health risks of low levels of lead exposure were recently published and should be followed [5].

Obtaining more complete data is important to improving the blood lead surveillance system. Health care providers and laboratories should report all required data elements, including the individual's address, race, and ethnicity in order to help identify high-risk populations. Enhanced case investigation and follow up are also needed to determine the source of lead exposures among adults with elevated BLLs.

Local and community-based efforts are also vital in reducing lead exposures among Nebraskans, especially in counties where rates of elevated BLLs are known to be high. Collaboration between NDHHS and local health departments can result in better communication of health risks to high-risk populations and identification of new exposure sources. Health care providers can also act to educate workers about the health risks of lead exposures among workers employed in high-risk industries and occupations and in those who are involved in hobbies known to involve lead.

References

[1] CDC. Adult blood lead epidemiology and surveillance--United States, 2008-2009. Morbidity and Mortality Weekly Report (MMWR), 2011; Jul 1;60(25):841-5. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6025a2.htm

[2] CDC. Fourth National Report on Human Exposure to Environmental Chemicals. Updated Tables, 2013. U.S. Department of Health and Human Services: Atlanta, GA. http://www.cdc.gov/exposurereport/pdf/fourthreport_updatedtables_sep2013.pdf

[3] U.S. Department of Health and Human Services. Healthy People 2020. Office of Disease Prevention and Health Promotion, Washington, DC. http://www.healthypeople.gov/2020/topicsobjectives2020/objectiveslist.aspx?topicid=30

[4] CDC. Adult Blood Lead Epidemiology and Surveillance (ABLES), 2013. US Department of Health and Human Services, CDC, National Institute for Occupational Safety and Health: Cincinnati, OH. http://www.cdc.gov/niosh/topics/ables/description.html.

[5] Kosnett MJ, Wedeen RP, Rothenberg SJ, Hipkins KL, Materna BL, Schwartz BS, Hu H, Woolf A. Recommendations for medical management of adult lead exposure. Environmental Health Perspectives. Mar 2007;115(3):463-71

[6] Louis ED, Jurewicz EC, Applegate L, Factor-Litvak P, Parides M, Andrews L, Slavkovich V, Graziano JH, Carroll S, Todd A. Association between essential tremor and blood lead concentration. Environmental Health Perspectives. Nov 2003;111(14):1707-11.

[7] CDC. Guidelines for the Identification and Management of Lead Exposure in Pregnant and Lactating Women, 2010. U.S. Department of Health and Human Services: Atlanta, GA. http://www.cdc.gov/nceh/lead/publications/leadandpregnancy2010.pdf

[8] CDC. Updated guidelines for evaluating public health surveillance systems: Recommendations from the guidelines working group. Morbidity and Mortality Weekly Report (MMWR), Jul 2001. 27;50(RR-13):1-35.

[9] Nebraska Department of Health and Human Services. Title 173, Chapter 1, Nebraska Administrative Code. Communicable Diseases: Reporting and Control of Communicable Diseases. http://www.sos.ne.gov/rules-and-regs/regsearch/Rules/Health_and_Human_Services_System/Title-173/Chapter-1.pdf

[10] Council of State and Territorial Epidemiologists (CSTE). Public Health Reporting and National Notification for Elevated Blood Lead Levels, 2009. http://c.ymcdn.com/sites/www.cste.org/resource/resmgr/PS/09-OH-02.pdf

[11] U.S. Census Bureau. 2011 County Business Patterns. http://www.census.gov/econ/cbp/index.html

[12] CDC, 2013. Very high blood lead levels among Adults — United States, 2002–2011, Morbidity and Mortality Weekly Report (MMWR), Nov 2013. Vol. 62(47);967-971. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6247a6.htm