Adult Blood Lead Levels in Minnesota

Rates and Trends, 2005-2012

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Lead exposure is associated with a number of adverse health events including peripheral neuropathy, anemia, renal damage and cognitive impairment. The vast majority of adult lead exposures occur in the workplace. By statute, all results from blood lead level (BLL) tests performed in Minnesota are submitted to the Minnesota Department of Health for surveillance purposes. We analyzed that data to examine lead exposure trends from 2005 through 2012. We found that an average of 548 persons 16 years of age and older had a BLL greater than 10µg/dL each year during that period. Analysis of the prevalence rate of elevated BLLs among adults for the years 2005–2012 showed a modest, nonsignificant decline among those with BLLs greater than 10µg/dL. Much has been done to reduce exposures and BLLs among young children. However, the policies and standards that protect workers have not been similarly adjusted, and many workers remain at risk of exposure. Although OSHA is responsible for developing and implementing policies and standards to protect workers, health care providers can play a critical role in identifying cases of lead exposure by asking patients about their occupation and industry. Those working in high-risk industries should be tested to determine whether they have been exposed and intervention is warranted.

Numerous adverse health effects are associated with lead exposure. They include peripheral neuropathy, anemia, renal damage, neurodevelopmental effects, cardiovascular disease, gastrointestinal disease, joint pain, reproductive complications and cognitive impairment.[1-6] Less understood is the extent to which those conditions affect adults who have low-but-constant levels of exposure.

The Occupational Safety and Health Administration (OSHA) established standards for lead exposure for general industry in 1978 and for the construction industry in 1995.[7] However, little has been done in recent years to address lead exposure among adults in the workplace. Of particular concern is lead exposure among those of reproductive age. Elevated blood lead levels (BLLs) have been associated with infertility, miscarriage and neurobiological fetal effects.[6] Ongoing research suggests the developing fetus is at risk for deleterious health outcomes even if the mother has been exposed to lead levels that are lower than those previously identified as being harmful.[1, 8-10]

Another significant concern related to workplace exposure is the potential for take-home exposure. Take-home exposure occurs when clothing and other items contaminated with lead-containing dust are brought into the home and children and others in the household come in contact with them. This is especially problematic for children as lead exposure can have significant consequences for their health and development. In the case of young children, symptoms of lead exposure are usually subtle, and the effects on neurodevelopment may not be evident until they start school.[11] Numerous cases of take-home lead exposure have been reported in Minnesota, accounting for approximately 10.4% of the elevated BLL cases among children 6 years of age and younger that were investigated by the Minnesota Department of Health between 2012 and 2014.[1,2,10,12-15] Adverse health effects are believed to occur at levels ≥10µg/dL.[11]

Because approximately 95% of cases of elevated BLLs in adults can be linked to occupational activities, policies and procedures can be instituted to prevent or limit exposure.[16] OSHA has established a permissible exposure limit (PEL) of 50 micrograms of lead per cubic meter of air (µg/m^3) over an eight-hour period for general industry and shipyards. Employers are required to take specific actions such as providing medical surveillance and blood lead level monitoring when a level of 30µg/m^3 is reported. (OSHA standards only account for exposures to lead in the air; they do not account for exposures that may occur through other routes, such as ingestion of lead dust that has settled onto surfaces.) If an employee is found with a BLL greater than 60µg/100g, he or she must be removed from the workplace until they have a repeated BLL of 40µg/100g or less. Individuals whose workplaces are not regulated by OSHA or do not exceed the PEL are unlikely to undergo medical surveillance for lead exposure.

The Minnesota Department of Health conducts ongoing surveillance of lead levels in adults to study exposure trends. This also allows us to distinguish between new and old/sustained cases and identify the industries with the greatest number of

cases. This article reviews lead exposure rates and trends in the state reported between 2005 and 2012.

Methods

State law requires that all blood lead test results for Minnesota residents be reported to the Minnesota Department of Health (Statute 144.9502). The department's Adult Blood Lead Epidemiology and Surveillance (ABLES) program collected relevant demographic information about gender, age, and occupation and industry for each adult whose lead test results were reported between 2005 and 2012. (Funding was discontinued in 2013 and re-established at a lower level in July 2015.[17])

Adult cases were defined as those with Minnesota or unknown residency status who were 16 years of age or older with at least one blood lead test result of ≥10µg/dL reported between 2005 and 2012. All adult lead tests are collected regardless of employment status (employed vs. unemployed). Individuals with elevated BLLs may be tested repeatedly throughout the calendar year.

We used the blood lead test with the highest result for an individual in a given year for our analysis. Cases were then assigned either incident or prevalent status, depending on test results for the individual during the previous year. An incident case is one in which an individual did not have an elevated BLL (≥10µg/dL) reported in the preceding year. Prevalent cases include both the incident cases as well as those in which an individual had measures at the level of interest in the preceding year. Annual incidence and prevalence counts and rates were calculated for the years 2005 to 2012 for three groups: those with BLLs ≥10µg/dL, ≥25µg/dL and ≥40µg/dL.

The Bureau of Labor Statistics provides estimates of the number of employed persons in Minnesota 16 years of age and older each year. We used those estimates to create prevalence and incidence rates of elevated BLLs per 100,000 employed persons. Trend analysis of these rates was completed using JoinPoint 4.04 a statistical software package developed by the National Cancer Institute.[18]

Findings

Between 2005 and 2012, 3,771 to 8,860 individual test results were reported annually to the Minnesota Department of Health (Table 1). For the years 2006 through 2012, the majority of reported test results were for women (57%). However, of the 493 cases with elevated lead BLLs (≥10 µg/dL) reported in 2012, only 34 (6.9%) were for women. Fifty percent of those women were younger than 47 years of age.

In 2005, a total of 607 individuals had a BLL ≥10µg/dL. In 2012, the number of individuals with a BLL at or above 10µg/dL lead declined to 493. However, the number of cases with a BLL ≥40µg/dL has remained fairly consistent over the eight-year period. Between three and 17

TABLE 1

Counts and rates of blood lead levels in Minnesotans 16 years of age and older, 2005–2012

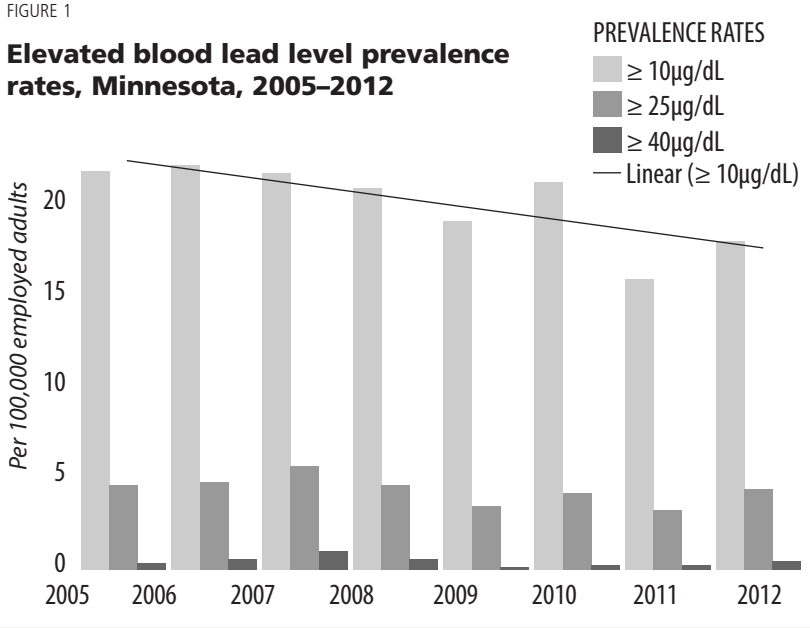
	2005	2006	2007	2008	2009	2010	2011	2012
Number of blood lead tests performed in individuals ≥ 16 years of age	4,770	7,525	8,675	9,944	9,357	9,767	8,896	8,854
Number of individuals ≥16 years of age with a blood lead test performed	3,771	6,487	7,569	8,860	8,297	8,603	7,898	7,746
Number of blood lead tests performed in those 16 – 29 years of age	1,173	2,232	2,512	3,375	3,010	2,958	2,677	2,622
Number of blood lead tests performed in those 30 - 49 years of age	1,708	2,658	3,017	3,406	3,294	3,456	3,248	3,129
Number of blood lead tests performed in those ≥ 50 years of age	890	1,597	1,986	2,079	1,993	2,189	1,973	1,995
Number of blood lead tests performed in females	2,051	3,096	3,476	3,546	3,396	3,776	3,384	4,342
Number of blood lead tests performed in males	1,712	3,382	4,069	5,283	4,890	4,821	4,507	3,402
Number of prevalent ≥10 µg/dL cases	607	616	593	563	509	572	428	493
Number of incident ≥10 µg/dL cases	282	283	271	242	191	240	181	265
Number of prevalent ≥25 µg/dL cases	131	134	156	125	96	113	88	123
Number of incident ≥25 µg/dL cases	41	38	56	52	39	60	41	66
Number of prevalent ≥40 µg/dL cases	11	18	29	17	5	7	7	12
Number of incident ≥40 µg/dL cases	6	7	17	12	3	6	6	11

incident cases were reported each year, for an annual average of nine cases.

Figure 1 shows the annual prevalence rates for 2005 through 2012. In 2012, the annual prevalence rates for cases with a BLL ≥10µg/dL, ≥25µg/dL and ≥40µg/dL were 17.8, 4.4 and 0.4 per 100,000 employed persons 16 years of age and older, respectively. In comparison, the annual incidence rates in 2012 for the three groups were 9.5, 2.4 and 0.4 per 100,000 employed persons 16 years of age and older, respectively. Analysis of prevalence and incidence rate trends for the three BLL groups over the eight-year period demonstrates a slight but not significant decline in most of the rates. Only the rate for prevalent BLL ≥10µg/dL group was found to have a significant, though very small (3.5% per year), downward trend ($P = .022$).

FIGURE 1

Elevated blood lead level prevalence rates, Minnesota, 2005–2012



Of the 493 cases with elevated (≥10µg/dL) BLL reported in 2012, 361 (73%) had information recorded about the industry in which the individual worked. Sixteen industries were identified as being associated with cases of elevated blood lead levels. The greatest number of cases were found in the refining/foundry and manufacturing industries (Figure 2). Small arms ammunition manufacturing, sporting and athletic goods manufacturing, and glass manufacturing in particular are associated with increased lead exposure. Jobs in the refining/foundry industry associated with increased exposure include primary smelting and refining of nonferrous metal, those in other nonferrous foundries and those in aluminum foundries (except die casting). Battery recycling and small arms ammunition manufacturing were the two job categories with the greatest number of cases, 235 and 27 respectively, in 2012.

Discussion

The ABLES data show some positive findings but also point to a need for continued surveillance of blood lead levels in adults and for additional efforts to reduce exposures.

The fact that women accounted for more than half of all blood lead test results is encouraging as it suggests that employers and/or health care providers are taking the initiative to ensure those of child-bearing age are being screened for lead exposure. Fortunately, only a few (6.9% in 2012) of the tests with elevated BLLs (≥10µg/dL) involved women, possibly because there are fewer of them working in the industries and occupations for which the risk of exposure is greatest. However, reduction of elevated blood lead levels is important in all persons of child-bearing age, as detrimental reproductive outcomes associated with lead exposure have been documented for both genders.

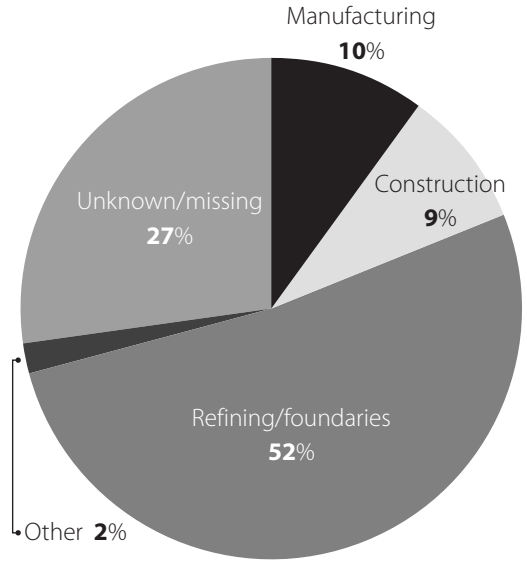
The data show there is well-warranted concern about take-home lead exposure, as poor health outcomes have been found at lower and lower levels of exposure.[1,3,6] More education is needed about preventing take-home exposure in children and others in the household, including pregnant women.

Being able to identify prevalent adult cases of elevated BLLs can be useful in pinpointing employers with ongoing unmitigated exposures. In addition, incident cases can help identify industries and occupations with unrecognized hazards that may benefit from education about how to prevent and reduce further exposure.

Physicians and other health care providers have a role to play in helping their patients avoid lead exposure. They can start by asking patients what they do for a living and for fun. Those with certain oc-

FIGURE 2

Percentage of prevalent cases (≥10µg/dL) by industry, Minnesota, 2012



cupations or hobbies (Table 2) should be offered a blood lead test (those who are pregnant or planning to become pregnant should definitely be tested). Physicians are also in a position to educate patients about the health hazards of lead exposure.

TABLE 2

Jobs with a high risk of lead exposure*

Artist (materials may contain lead)
Auto repair (car parts may contain lead)
Battery manufacturer (batteries contain lead)
Bridge reconstruction worker (old paint may contain lead)
Construction worker (materials may include lead)
Firing range instructor and gunsmith (ammunition contains lead)
Glass manufacturer (lead may be used in glass production)
Lead manufacturer
Lead miner
Lead refiner
Lead smelter
Manufacturer of bullets, ceramics and electrical components (all contain lead)
Painter (old paint and commercial paint may contain lead)
Plastic manufacturer (materials may contain lead)
Plumber and pipefitter (pipes may contain lead)
Police officer (ammunition contains lead)
Radiator repair (radiators may contain lead)
Recycler of metal, electronics and batteries (materials may contain lead)
Rubber product manufacturer (materials may contain lead)
Shipbuilder (materials used may include lead)
Solid waste incinerator operator (waste may contain lead)
Steel welder (galvanized steel is coated in part with lead)

*This list is not exhaustive.

Source: www.cdc.gov/niosh/topics/lead/jobs.html

Conclusion

Lead exposure among working-age adults in Minnesota continues to be a concern. Continued surveillance of at-risk groups is critical for monitoring its status. Surveillance begins when employers or health care providers identify at-risk patients and order blood tests. The results of those tests can help target education as well as prevention and intervention strategies to the appropriate individuals and employers. With coordinated efforts among state agencies, health care providers, industry and individuals, we can reduce lead exposure in working adults and prevent the detrimental effects it can have on health. **MM**

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The findings and opinions presented are solely the responsibility of the authors and do not necessarily represent the official views of the National Institute for Occupational Safety and Health.

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Resources for Physicians

For identifying lead poisoning:

- Minnesota Department of Health's blood lead screening guidelines (www.health.state.mn.us/divs/eh/lead/guidelines/index.html)

For addressing lead exposure in pregnant women:

- Minnesota Department of Health's guidelines and protocols for addressing lead exposure among pregnant women (www.health.state.mn.us/divs/eh/lead/guidelines/index.html)

For information about how to deal with a case of adult lead exposure:

- Recommendations for medical management of adult lead exposure. Environmental Health Perspectives. (www.ncbi.nlm.nih.gov/pmc/articles/PMC1849937/)
- Council of State and Territorial Epidemiologists' management guidelines for blood lead levels in adults (http://c.ymcdn.com/sites/www.cste.org/resource/resmgr/OccupationalHealth/ManagementGuidelinesforAdult.pdf)

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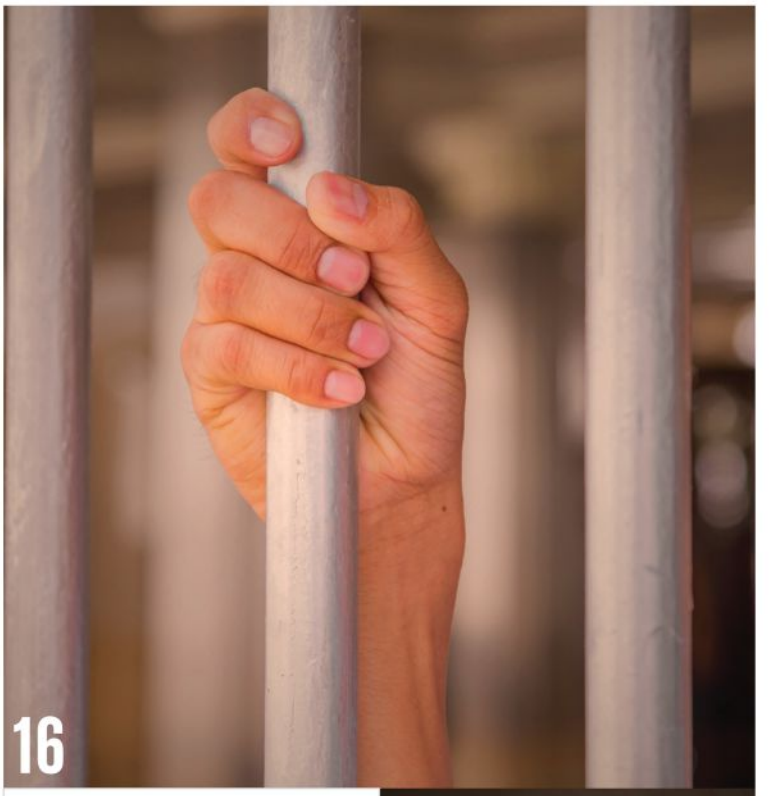

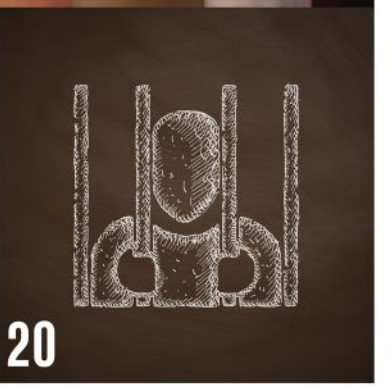

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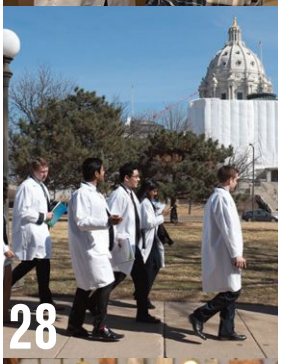

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