2016 Blood Lead Surveillance Report

LEAD AND HEALTHY HOMES PROGRAM

DEPARTMENT OF HEALTH

2016 Blood Lead Surveillance Report

Minnesota Department of Health
Lead and Healthy Homes Program
PO Box 64975
St. Paul, MN 55164-0975
(651) 201-4620
health.asbestos-lead@state.mn.us
www.health.state.mn.us

As requested by Minnesota Statutes 3.197: This report cost approximately $5,000 to prepare, including staff time, printing and mailing expenses. Funding for the creation of this report was provided by the Centers for Disease Control and Prevention (CDC) Childhood Lead Poisoning Prevention Grant CDC-RFA-EH14-1408PPHF14

Upon request, this material will be made available in an alternative format such as large print, Braille or audio recording. Printed on recycled paper.

Contents

Acronyms and Abbreviations

ABLES	Adult Blood Lead Epidemiology and Surveillance Program
BLIS	Blood Lead Information System
BLL	Blood Lead Level (µg/dL)
CDC	Centers for Disease Control and Prevention
DHS	Minnesota Department of Human Services
EBLL	Elevated Blood Lead Level
EPSDT	Medicaid's Early and Periodic Screening, Diagnosis, and Treatment Program
IQ	Intelligence Quotient
LHHP	MDH Lead and Healthy Homes Program
MA	Minnesota Medical Assistance, Minnesota's Medicaid program
M-CLEAN	Minnesota Collaborative Lead Education and Assessment Network
MDH	Minnesota Department of Health
MEDSS	Minnesota Electronic Disease Surveillance System
MN	Minnesota
MNCare	MinnesotaCare, a public health care program for Minnesotans with low incomes
MNOSHA	Minnesota Occupational Safety and Health Administration
NIOSH	National Institute for Occupational Safety and Health
U.S.	United States
WDHS	Wisconsin Department of Health Services
µg/dL	Micrograms of lead per deciliter of whole blood

Executive Summary

This 2016 Blood Lead Surveillance Report describes the activities of the Minnesota Department of Health (MDH) Lead and Healthy Homes Program (LHHP) and the data analysis from the MDH Blood Lead Information System (BLIS) for the 2016 calendar year. The report contains a description of the trends in lead testing and elevated blood lead levels in Minnesota.

In 2016, over 88,000 Minnesota children received at least one blood lead test. Of these, 862 (about 1%) were found to have an elevated blood lead level (5+ µg/dL). This number has been decreasing over the past decades. However, there are some populations and areas in Minnesota that have a much higher proportion with elevated blood lead levels than others, reaching over 10% in some areas.

Childhood blood lead screening has improved in Minnesota since 2000. Approximately 80% of children born in 2013 were tested at least once prior to their third birthday (in 2016), compared to 42% of those born in 2000. However, further increases in the percent tested have not been seen since the 80% point was first reached by children born in 2008. In addition, only about one third of children receive blood lead tests at both one and two years of age, as MDH recommends.

Once a child is detected as potentially having an elevated blood lead level (5+ µg/dL) through a screening test, a diagnostic follow-up test is recommended. In 2016, 62% of children with an elevated screening test received a follow-up test within the recommended time period. Local public health agencies provide case management services, ranging from educational mailings to home visits, to all children with elevated blood lead levels. If a child's blood lead level is very elevated, over 15 µg/dL, an environmental risk assessment of the child's residence by a licensed risk assessor is mandated. In 2016, there were 85 children with confirmed blood lead levels over 15 µg/dL. Risk assessments identified lead-based paint and lead contaminated dust hazards in the homes of most of these children.

In addition to childhood lead exposure, adults can also be exposed to lead. Most adult lead exposures are occupational. In 2016, 1,059 Minnesota adults were found to have elevated blood lead levels. Common industries where workers were exposed in 2016 included secondary smelting, sporting and athletic goods manufacturing (includes fishing sinker manufacturing), and ship building and repairing.

Lead exposure surveillance through the Minnesota Blood Lead Information System enables the identification and response to lead exposures as well as monitoring of trends and patterns in the population. This system requires ongoing investment to maintain data collection, entry, analysis, and quality assurance.

Lead Exposure

Although the toxicity of lead has been known for thousands of years, lead remains one of the most common environmental health threats to children. There are many sources of lead exposure, such as soil contaminated from years of leaded gasoline use, lead dust accidentally brought home from parents' workplaces and hobby areas, lead in plumbing, and some imported products and traditional remedies. However, deteriorated lead paint in homes is the main source of lead exposure for U.S. children today. As lead paint deteriorates, it creates fine dust that is identical in appearance to ordinary house dust. Although lead paint was banned for residential use in 1978, many older homes still contain lead paint. It is estimated that nearly one million homes throughout Minnesota still have lead paint.

Elevated levels of blood lead occurring during the first years of life may not produce symptoms until the children enter school and display learning difficulties, reduction in IQ, or behavior problems.

Children less than six years old are most vulnerable to lead's toxicity due to their growing bodies, nutritional needs, mouthing behavior, and spending time on the floor. Pregnant women and the developing fetus are also at greater risk because lead easily passes through the placenta to the fetus. The changing nutritional needs of the mother also cause release of lead stored in bone. Certain populations are at increased risk of lead exposure. For example, children enrolled in medical assistance programs are more likely to live in poverty and therefore live in old, poorly maintained housing, which is more likely to contain lead paint hazards.[1,2] Refugees arriving in Minnesota have also been found to be at increased risk for elevated blood lead levels, potentially due to lead exposure prior to their arrival.[3]

---

[1] Centers for Disease Control and Prevention (CDC). Recommendations for Blood Lead Screening of Medicaid-Eligible Children Aged 1-5 Years: an Updated Approach to Targeting a Group at High Risk. MMWR Morb Mortal Wkly Rep. 2009; 58(RR-9).

[2] Minnesota Department of Health, Minnesota Center for Health Statistics. (2014). White Paper on Income and Health (PDF).

[3] Zabel EW, Smith ME, O'Fallon A. Implementation of CDC Refugee Blood Lead Testing Guidelines in Minnesota (PDF). Public Health Rep. 2008;123;111-123.

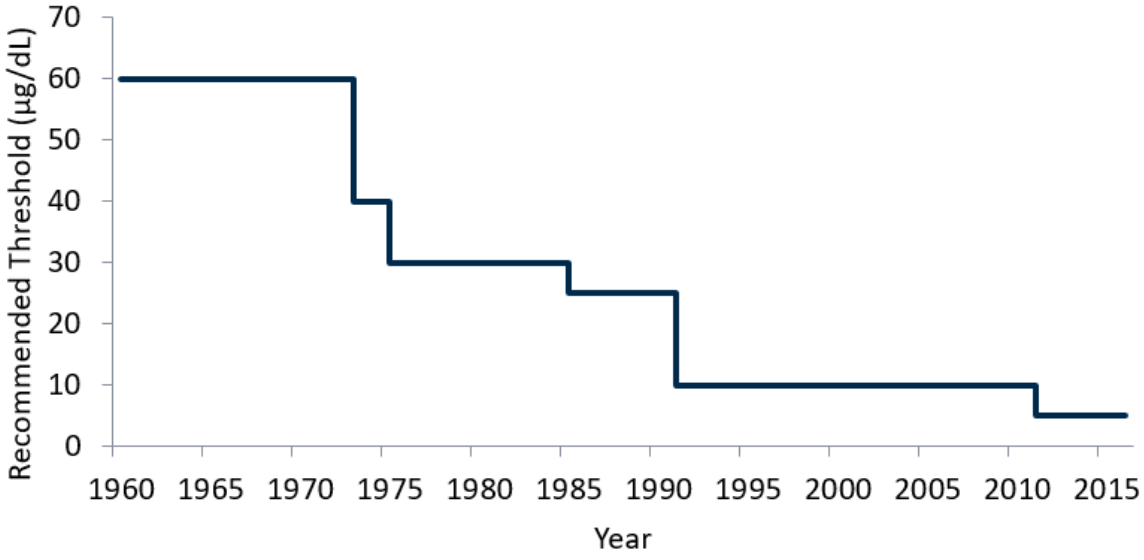
Elevated Blood Lead Levels

The Centers for Disease Control and Prevention's (CDC) current reference level for an elevated blood lead level is 5 micrograms of lead per deciliter whole blood (µg/dL) (**Figure 1**). This value is based on the 97.5th percentile of the blood lead distribution among U.S. children and is expected to be lowered as average blood lead levels continue to decline. Confirmed blood lead test results above the 5 µg/dL reference value are expected to trigger a public health response. CDC also acknowledges that there is no safe level of exposure to lead, and the effects of lead exposure appear to be irreversible. Therefore, primary prevention, or preventing lead exposure before it can start, is crucial.

Under Minnesota Statutes 144.9501, Subd. 9, the definition of an elevated blood lead level (EBLL) in Minnesota is a diagnostic blood lead test of at least 5 µg/dL, consistent with Minnesota case management guidelines and CDC recommendations.

Minnesota Statutes 144.9504 mandates environmental interventions for venous blood lead levels of 15 µg/dL or greater in children less than six years old. For levels of 5 µg/dL or greater, local public health nurses work with families to bring down elevated lead levels. For most children and adults exposed to lead, identification and elimination of the source of lead is the primary intervention.

Figure 1. Historic CDC Recommendations of Elevated Blood Lead Level Thresholds for Public Health Response



State Blood Lead Guidelines

MDH has a set of four guidelines available for lead: Blood Lead Screening for Pregnant Women, Childhood Blood Lead Screening, Childhood Blood Lead Case Management, and Childhood Blood Lead Clinical Treatment, which may be found at the MDH Web site at Lead. These guidelines are intended to establish standardized screening practices and minimum levels of care for providing services to children. However, local health departments that have greater resources available may wish to take a more rigorous approach to case management.

Blood Lead Screening Guidelines for Pregnant Women

REVISED AUGUST, 2015

The Blood Lead Screening Guidelines for Pregnant Women in Minnesota are designed to assist health care providers in screening pregnant women for elevated blood lead levels. Not every woman is at risk for lead exposure, so a risk screening questionnaire should be used to decide whether testing is recommended. Examples of risk factors for lead exposure include occupational exposure of the mother or another household contact, remodeling a home containing lead paint, using non-commercial home remedies that contain lead, and pica behavior. Identifying and preventing elevated blood lead levels in pregnant women also serves to protect the developing fetus. The 2015 revision reflects the current definition of an elevated blood lead level (5+ µg/dL), provides additional details on sources of lead, and includes resources specific to Minnesota.

Childhood Blood Lead Screening Guidelines

REVISED MARCH, 2011

The MDH Childhood Blood Lead Screening Guidelines direct physicians to order blood lead tests for:

1. Children residing in specific geographic areas that have high rates of elevated blood lead
2. Children matching specific groups that have high rates of elevated blood lead

Universal testing is recommended for children residing in Minneapolis and St. Paul and those recently arriving from other major metropolitan areas or other countries. Testing is also recommended for children receiving Medicaid. The tests are typically performed when the child is one and two years old, but may be done at any time if the parent is concerned or if a high-risk activity (e.g. remodeling a home built before 1950) has recently occurred. It is recommended that physicians use the Minnesota blood lead screening risk questionnaire to help determine if a child is at high risk for lead exposure available at Childhood Blood Lead Screening Guidelines for Minnesota (PDF).

Childhood Blood Lead Case Management Guidelines

REVISED MARCH, 2011

The Case Management Guidelines work in concert with the MDH Blood Lead Screening Guidelines for Minnesota to identify and manage lead exposure in children. A qualified case manager should oversee the treatment and recovery of each child, and ensure that steps are taken to prevent further exposure of the child to potential sources of lead. Appropriate steps are presented for both capillary and venous test results.

Childhood Blood Lead Clinical Treatment Guidelines

REVISED MARCH, 2011

The Childhood Blood Lead Clinical Treatment Guidelines are designed to assist health care providers in following up with patients with elevated blood lead levels. The clinical treatment guidelines recommend engaging families through education at blood lead levels of 5–10 µg/dL. Additional diagnostic tests and interventions, such as radiographs, additional bloodwork, and chelation therapy, are recommended for higher blood lead levels.

Data Collection

Lead Testing

Since not all Minnesota children have a high risk for lead exposure, targeted testing based on established risk factors is recommended for most areas of the state. Children should be evaluated using a screening questionnaire to determine whether they have risk factors for lead exposure; the goal is to test all children who are at risk for exposure to lead. Because lead testing is neither universal nor randomly sampled, the data in this report are not generalizable to the population of children living in Minnesota. However, a large proportion of Minnesota children are tested at least once prior to their third birthday. Of children born in 2013, 80% were tested at least once by their third birthday in 2016.

The blood specimens used in blood lead testing are drawn from either capillaries or veins. Tests on capillary blood are considered “screening” tests. They are drawn from a finger stick, allowing them to be performed in a wide range of settings. However, Minnesota lead testing data suggest that about two-thirds of elevated capillary screening tests may be false positives. Therefore, a follow-up diagnostic test is needed to confirm an elevated capillary test. Venous specimens are drawn from a vein and are considered “diagnostic” because they are less prone to false positives than capillary tests. However, they can be more difficult to obtain. Venous tests are required to initiate an environmental investigation of an elevated lead result.

The MN Blood Lead Information System (BLIS)

MDH maintains a blood lead information system (BLIS) for tracking and monitoring trends in blood lead levels in adults and children in Minnesota. Laboratories submit results to the LHHP, as mandated by Minnesota Statutes 144.9502. The data are used to help identify populations at risk for elevated blood lead levels (EBLLs), to help ensure that screening services are provided to groups identified as having the highest risk of lead exposure, and to ensure that environmental and medical follow-up are provided to children with EBLLs. Data are also used to plan, develop, and implement primary prevention programs.

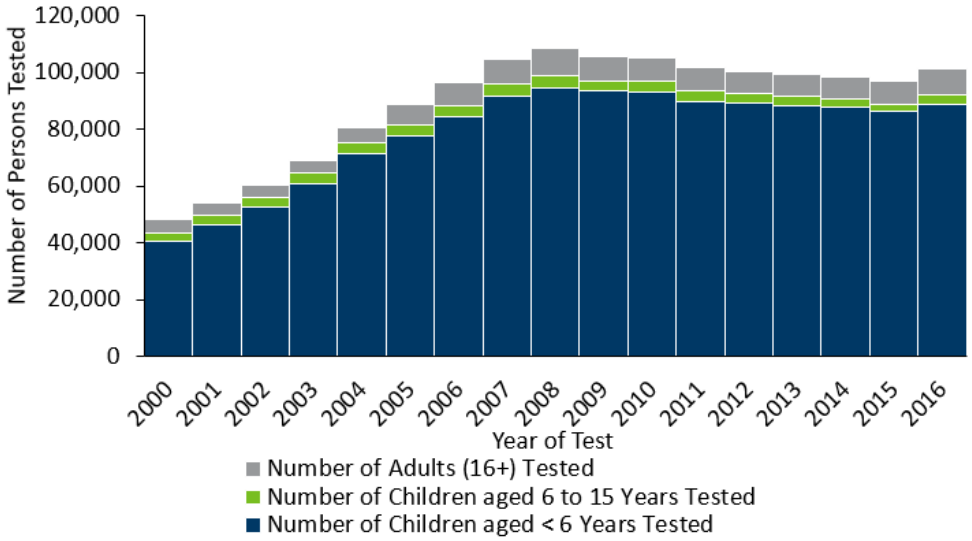
Statewide Surveillance Data

Statewide data are available starting from 1995. Data for years 2000–2015 are shown for comparison to the 2016 data. The number of children tested for lead in Minnesota increased from 2000 through 2008, then began to decrease during 2009–2015 and increased slightly in 2016. In 2016, 88,620 children aged less than 6 years were tested (**Figure 2**).

Blood lead screening for older children, aged 6 to 15 years, and adults is much less common than for young children. Older children are not recommended to be routinely screened and tend to only receive blood lead tests if a provider has reason to suspect the child may be lead-exposed, such as recent immigration to the U.S., a lead-related hobby, or the child is symptomatic. In 2016, 3,274 children aged 6 to 15 years received a blood lead test.

Adults are primarily blood lead tested if they are pregnant or at risk for occupational lead exposure. In many cases, this testing is part of routine medical monitoring programs implemented by their employers. In 2016, 9,281 adults (aged 16+) were blood lead tested.

Figure 2. Number of Persons Blood Lead Tested by Year and Age Group, Minnesota, 2000–2016.

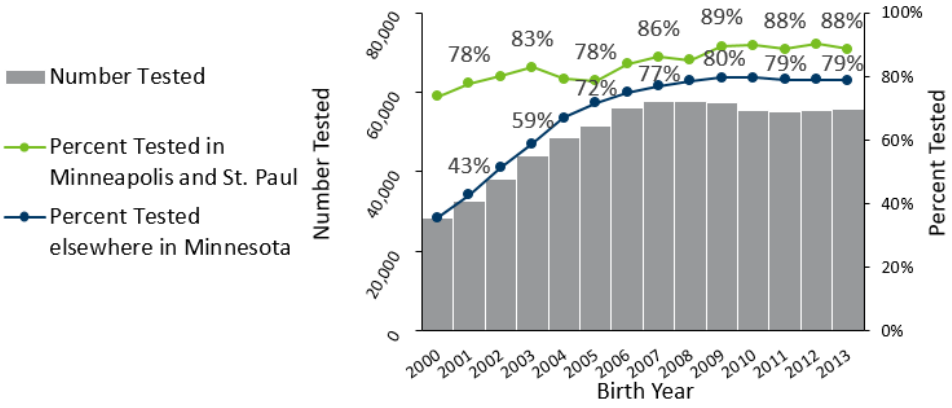


Childhood Blood Lead Screening

While Minnesota's blood lead screening guidelines do not recommend universal testing for children in all areas of the state, the percentage of children tested has been increasing over time. To examine testing rates in children, a birth-cohort approach can be useful. This approach looks at all children born in a specific year and measures how many of these children receive blood lead screening at specific benchmarks. These benchmarks include the percent of children who receive at least one test by three years of age, the percent who receive a blood lead test around one year of age, the percent tested around two years of age, and the percent tested at both one year and two years of age.

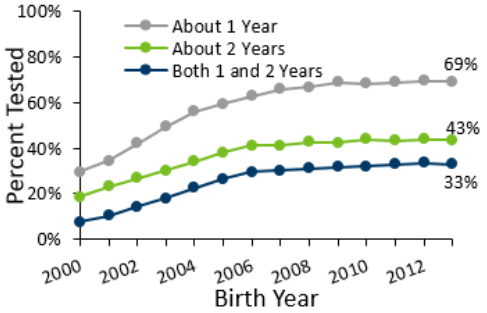
The most recent birth cohort to have been observed for a full three years is children born in 2013. Among the 69,183 children born in 2013, 55,611 children (80%) statewide were tested at least once by age three years. Among children in Minneapolis and St. Paul, where universal screening is recommended, 88% were tested at least once. Elsewhere in the state, 79% were tested at least once. (**Figure 3**)

Figure 3. Number and Percent of Children Tested at Least Once by Age 3 Years by Birth Cohort



Within the 2013 birth cohort, while 80% of children were tested at least once by age three, 69% were tested around one year of age (9 to 18 months), 43% were tested around two years of age (18 to 36 months), and only 33% were tested at both one and two years of age (Figure 4). This indicates that many providers are testing children at one year but not two years of age.

Figure 4. Children Tested at 1-Year and 2-Years of Age, by Birth Year



Two year old children interact with their environments differently than one year old children. This can change the risk for lead exposure between these ages, even if the child's house or other risk factors do not change.

This is supported by MDH surveillance data; about 0.5% of children with non-elevated (<5 µg/dL) blood lead levels measured at one year of age who were tested at two years of age have a confirmed elevated blood lead level at the time of the second test. This indicates that the practice of not testing children at two years of age may lead to lead-exposed children going undetected.

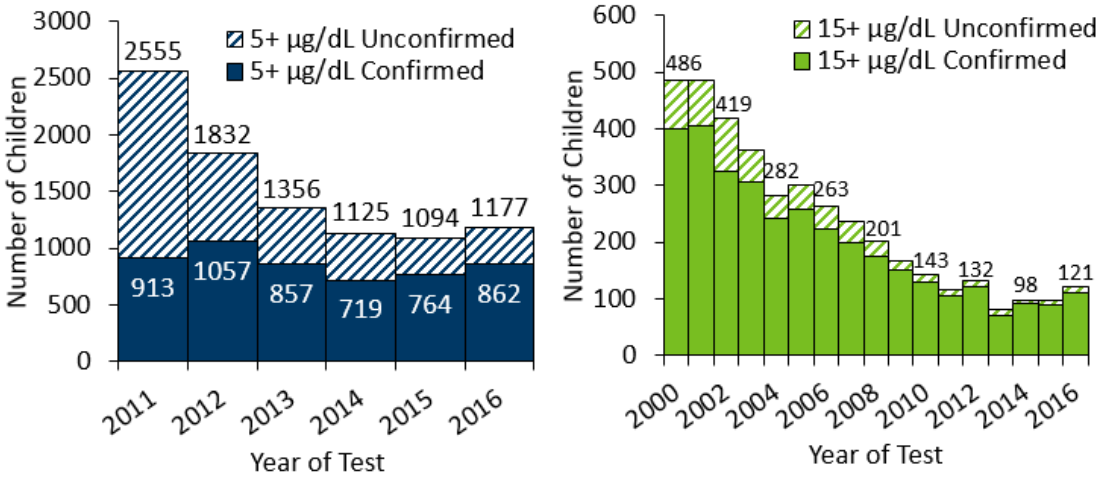
In an effort to improve blood lead screening practices, MDH is targeting clinics with testing practices that do not conform to MDH guidelines for outreach including provider education and health system quality improvement coordination.

Blood lead screening statistics are available at the county scale through the MDH Data Access Portal's Childhood Lead Exposure page.

Elevated Blood Lead Levels in Children

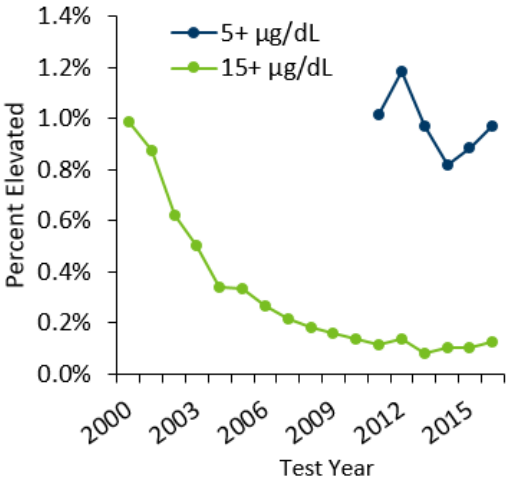
Trends in the prevalence of lead exposure in Minnesota children can be understood through examining trends in the number of children with detected EBLLs per year (**Figure 5**). The number of EBLL cases has continued to decrease in recent years. However, in 2016, there were still 862 Minnesota children who had confirmed blood lead levels of at least 5 µg/dL, 112 of whom had confirmed blood lead levels of at least 15 µg/dL. The highest confirmed blood lead level identified in a child from Minnesota in 2016 was 96 µg/dL.

Figure 5. Number of Children with Confirmed and Unconfirmed Elevated Blood Lead Levels (5+ µg/dL and 15+ µg/dL) by Year of Test, 2000–2016



A confirmed elevated blood lead level is defined here as any elevated venous blood lead test result or any elevated capillary blood lead test result followed-up by a second elevated capillary test within 12 weeks. [4]An unconfirmed elevated blood lead level is an elevated capillary blood lead test without a follow-up test. Elevated capillary tests that receive a non-elevated venous follow-up test within 12 weeks are excluded since these are likely to be false positive tests. The true number of children with elevated blood lead levels is likely somewhere between the total (confirmed and unconfirmed) count and the confirmed count. In 2016 for levels 5 µg/dL or greater, this would be somewhere between 862 and 1177. In 2016, 88,620 children were blood lead tested and 862 (1.0%) had a confirmed EBLL of 5 µg/dL or greater while 112 (0.1%) had a confirmed EBLL of 15 µg/dL or greater (**Figure 6**).

Figure 6. Percent of Children with Confirmed Elevated Blood Lead Levels by Year, Among Tested Children, 2000–2016



Additional statistics on elevated blood lead levels among Minnesota children are available on the MDH Data Access Portal's Childhood Lead Exposure page.

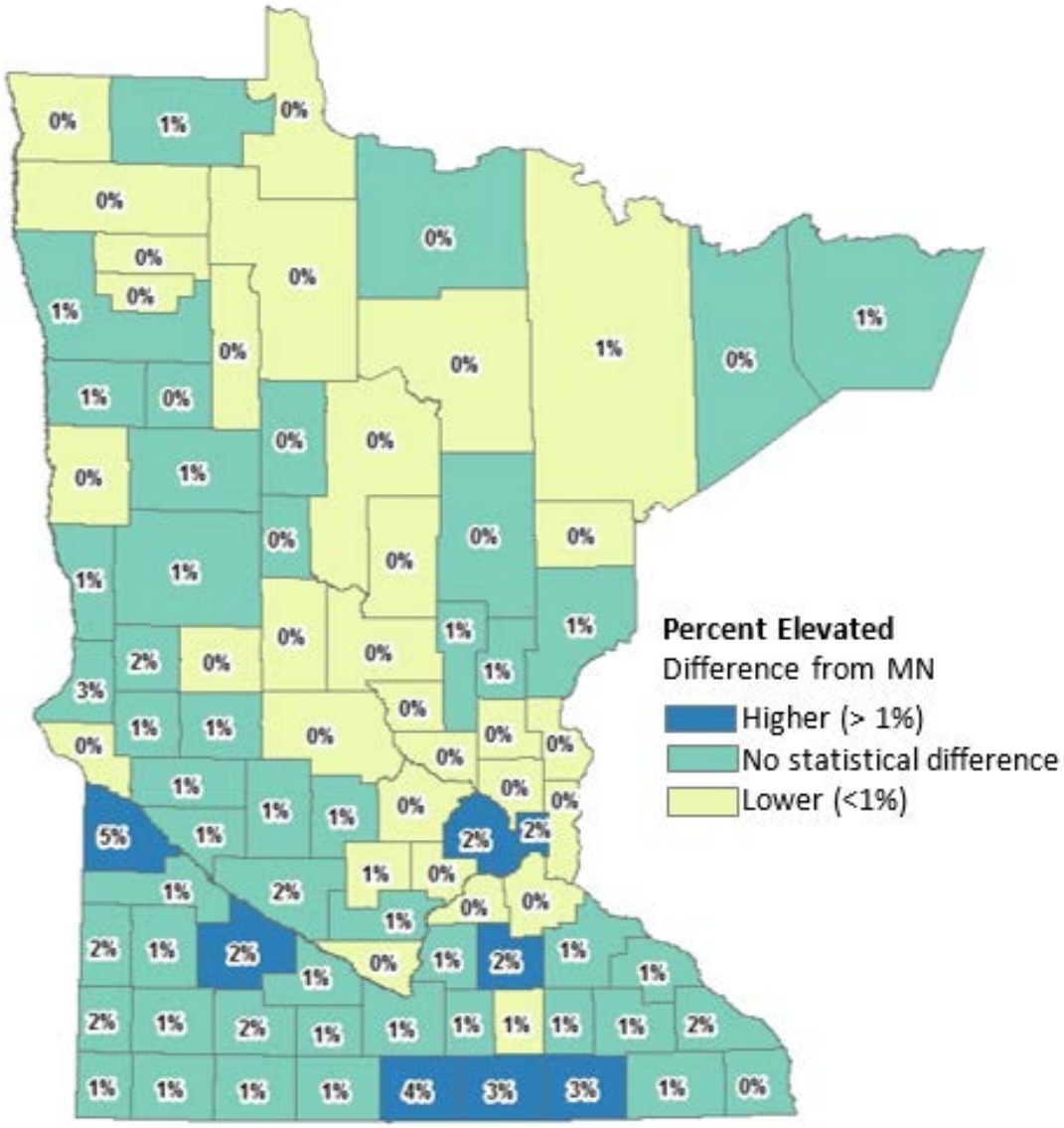
Geographic Variability in Elevated Blood Lead Levels

While the percent of children with elevated blood lead levels among tested children continues to decline statewide, there remain geographic areas where a much higher percent of children are found to have EBLLs. To estimate the percent EBLL at county and sub-county geographic scales, five years (2011–2015) of blood lead testing data were compiled to increase estimate precision. Within these five years, the number of children with EBLLs and the number of children blood lead tested at least once were counted for each county and Census tract, based on the child's residential address at the time of their highest confirmed blood lead test. Statewide, the percent of children tested with a confirmed 5+ µg/dL EBLL was about 1%.

At the county scale, the percent EBLL ranged from 0% to nearly 5%. Counties with percent EBLL statistically significantly higher than the statewide percent EBLL included Fairbault, Freeborn, Hennepin, Lac qui Parle, Mower, Ramsey, Redwood, and Rice. The combined percent EBLL in these counties was 2%, nearly twice as high as the statewide percent EBLL. (**Figure 7**)

[4] Centers for Disease Control and Prevention (CDC). Standard Surveillance Definitions and Classifications for Lead. Retrieved 7/17/2017.

Figure 7. Percent of Children with Confirmed Elevated Blood Lead Levels (5+ µg/dL) by County, Among Tested Children, 2011–2015



At a finer geographic scale, the Census tract, a similar pattern is visible, with high percent-EBLL geographic areas in the inner-metropolitan region and in some areas in the south and southwest of the state and low percent-EBLL areas in the outer-metropolitan region as well as some areas of the central region of the state (**Figure 8**).

Figure 8. Percent of Children with Confirmed Elevated Blood Lead Levels (5+ µg/dL) by Census Tract, Among Tested Children, 2011–2015, State and Metro

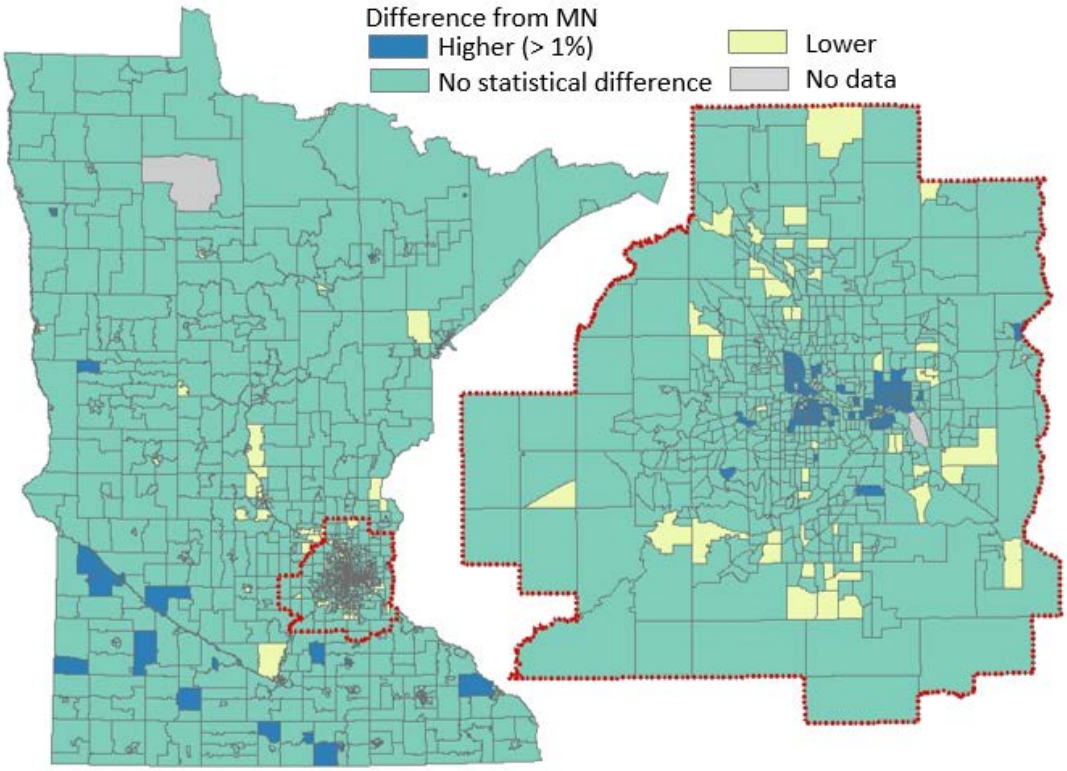


Table 1. Summary of the Distribution and Characteristics of High Percent-EBLL Census Tracts, 2011–2015

	High Percent-EBLL Census Tracts		Tracts Not Different from State	Low* Percent-EBLL Tracts	Statewide
	Very High*	High*			
Number of Tracts	30	105	1125	68	1328
Children Tested	10,884	31,790	235,643	28,397	334,962
EBLL Cases, n (%)	727 (7%)	1125 (4%)	1548 (1%)	7 (0%)	3675 (1%)
Minneapolis/St Paul tracts, n	26	68	103	0	197
Outer Metro Region tracts, n	2	6	450	44	502
Cities Outside the Metro tracts, n	1	13	109	7	130
Rural Area tracts, n	1	18	463	17	499
Percent of Houses Built Pre-1950	58%	50%	20%	8%	22%
Percent of Population in Poverty	31%	22%	10%	8%	11%
Percent Persons of Color	65%	39%	16%	18%	18%

*Tracts were classified as 'High' percent-EBLL if the tract percent was significantly greater than the statewide percent (>1.1%). 'Very High' percent-EBLL tracts had a percent significantly more than 3 times the statewide percent (>3.3%). 'Low' percent-EBLL tracts had percents significantly lower than the statewide percent (<1.1%).

High percent-EBLL areas are not distributed randomly throughout the state. The majority of high percent-EBLL tracts are in the cities of Minneapolis and St. Paul, containing 94 of 135 high percent-EBLL tracts (70%) while only containing 15% of all tracts statewide. The distribution of the high percent-EBLL Census tracts as well as the populations living in them is described in **Table 1**. Tracts with higher percent-EBLL tended to have more houses built prior to 1950, a larger proportion of the population living in poverty, and a larger proportion of the population being persons of color than lower percent-EBLL tracts.

Demographics

The demographic indicators gender, race and ethnicity are collected by MDH with blood lead test results. While reporting gender and race with the results of a blood lead test is required under Minnesota Statutes 144.9502, MDH accepts records where these are reported as "Unknown". Gender data tends to be mostly complete; race and ethnicity are often reported as "Unknown." This creates a problem for monitoring racial disparities in lead testing and lead exposure.

In 2016, blood lead test results for children aged less than six years were reported for 45,567 males, 42,958 females, and 95 persons whom gender was not reported. The percentage of confirmed EBLLs was not different between males and females (**Table 2**).

Racial and ethnic disparities in the prevalence of lead poisoning have been shown in national data. A recent summary of 2007–2010 data from the National Health and Nutrition Examination Survey for U.S. children aged 1–5 years showed the geometric mean blood lead level of White, non-Hispanic children was 1.3 µg/dL while that of Black, non-Hispanic children was significantly higher at 1.8 µg/dL. The geometric mean blood lead level of Mexican American children was also 1.3 µg/dL.[5] However, individual race and ethnicity data reported with blood lead tests is too incomplete to provide reliable estimates of racial and ethnic disparities in Minnesota (see *Evaluation of BLIS* section of this report). The LHHP is working to improve data completeness.

Table 2. Summary of the Reported Demographic Characteristics of Children Aged < 6 Years Blood Lead Tested in 2016 and EBLL Cases (Confirmed ≥5 µg/dL)

Demographic	Tested, n (%)	EBLL Cases, n	Percent EBLL
Gender			
Female	42,958 (48%)	411	1.0%
Male	45,567 (51%)	450	1.0%
Unknown	95 (0%)	1	1.1%

[5] Centers for Disease Control and Prevention (CDC). Blood Lead Levels in Children Aged 1-5 Years – United States, 1999-2010. MMWR Morb Mortal Wkly Rep; 2013; 62(13):245-248.

Special Populations: Medicaid Enrolled Children

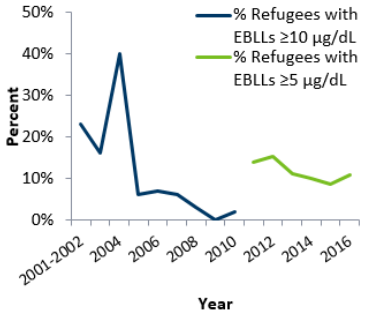
Nationally, children enrolled in Medicaid tend to be more than twice as likely to have elevated blood lead levels as non-enrolled children.[6] However, this disparity may differ between states and the CDC has recommended states develop screening plans consistent with their local risk patterns.[7] A previous study of Minnesota blood lead surveillance data has indicated that the disparity in EBLL prevalence between children enrolled in Medical Assistance (MA) or MinnesotaCare (MNCare), Minnesota's Medicaid programs, and those not enrolled is similar to the national disparity, with an approximately 2-fold difference in prevalence.[8] MA and MNCare's Early and Periodic Screening, Diagnosis, and Treatment (EPSDT) program requires that well-child visits include blood lead testing at both 12 and 24 months. The MDH Blood Lead Screening Guidelines also recommend universal screening at 12 and 24 months for all MA or MNCare enrolled children.

The MDH LHHP and DHS are currently revising data sharing agreements and matching protocols so that blood lead screening and blood lead levels can be more closely monitored in the Medicaid enrolled child population.

Special Populations: Refugee Children

Refugees are persons who are forced to leave their home country because of disasters, war, or persecution. Refugees come to Minnesota with a special immigration status and are a population at high risk for lead exposure. Refugees may have lead exposure in their country of origin, and further exposure once they are in the U.S. The Division of Infectious Disease Epidemiology, Prevention, and Control at MDH collects demographic data on refugee children aged less than 17 years entering the state who receive an initial health screening. Blood lead tests are routinely matched to refugee information (Figure 9). The rate of elevated blood lead levels for refugees is nearly ten times higher than the percentage of elevated blood lead levels among Minnesota children in general.

Figure 9. Elevated Blood Lead Levels (EBLLs) among Refugee Children Who Received a Blood Lead Test



[6] Centers for Disease Control and Prevention (CDC). Blood Lead Levels in Children Aged 1-5 Years – United States, 1999-2010. MMWR Morb Mortal Wkly Rep; 2013; 62(13):245-248.

[7] Centers for Disease Control and Prevention (CDC). Recommendations for Blood Lead Screening of Medicaid-Eligible Children Aged 1-5 Years: an Updated Approach to Targeting a Group at High Risk. MMWR Morb Mortal Wkly Rep. 2009; 58(RR-9). https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5809a1.htm

[8] Centers for Disease Control and Prevention (CDC). Recommendations for Blood Lead Screening of Medicaid-Eligible Children Aged 1-5 Years: an Updated Approach to Targeting a Group at High Risk. MMWR Morb Mortal Wkly Rep. 2009; 58(RR-9).

Case Management

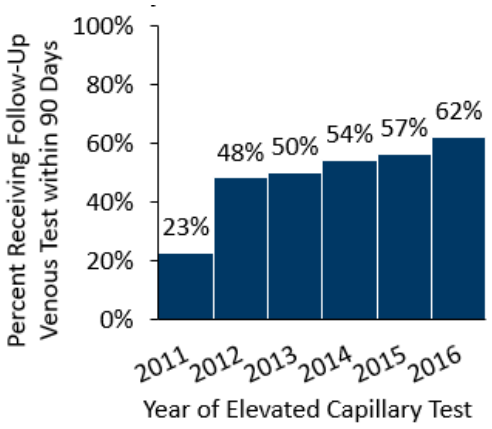
The LHHP provides technical assistance and coordinates with local public health agencies in the state of Minnesota to ensure case management services are available for children with blood lead levels of at least 5 µg/dL. These activities include:

- Assuring case management activities and follow-up testing for children and pregnant women are performed in accordance with MDH guidelines;
- Providing educational materials, in appropriate languages, to assist in communicating lead exposure prevention measures;
- Communicating regularly with the Asbestos and Lead Compliance Unit to assess progress on open lead cases and facilitate communication between the Asbestos and Lead Compliance Unit and local lead case managers.

Follow-up Testing

MDH recommends follow-up tests for children with elevated blood lead screening tests. The period of time recommended for re-testing varies according to the initial blood level and the test type. Diagnostic venous testing is recommended for all capillary results of 5 µg/dL or greater. Of the 1407 Minnesota children whose first elevated blood lead level was a capillary test in 2016, 878 (62%) received a follow-up venous test within 90 days. This is an improvement over 2011, the first year in which follow-up venous testing for capillary results in the 5-9.9 µg/dL range was recommended, when just 23% received follow-up tests within 90 days.

Figure 10. Percent of Children with Initial Capillary Tests ≥ 5 µg/dL Receiving a Follow-up Venous Test within 90 Days



Timely follow-up testing is important both for identifying cases so that public health responses can be initiated and for detecting false-positive screening tests. Capillary tests, typically used for blood lead screening, are prone to false positive results. These can be due to contamination on a child's finger or other contamination during the testing and analysis process. A false positive test is defined as an elevated capillary test with a follow-up venous test than is below 5 µg/dL within 90 days. In 2016, 620 of the 878 (70%) initial elevated capillary tests that received a venous follow-up test within 90 days were false positives. This proportion is dependent on the prevalence of elevated blood lead levels in the population and is expected to increase as the prevalence decreases.

Healthcare providers can help prevent false positive capillary tests by thoroughly cleaning a child's finger prior to conducting a capillary test to remove any surface lead contamination.

This should include thoroughly washing the child's hand with soap and water before drawing blood, wearing gloves, and collecting only the blood that has "beaded" on the fingertip while avoiding the blood that has run down the finger.[9]

Environmental Risk Assessments

For children found to have an elevated blood lead level, identifying and removing the source of lead exposure is a priority. Not only will this prevent further exposure to the child who was already exposed, it will also prevent other children from being exposed to that lead hazard. Minnesota Statutes 144.9504, requires assessing agencies to ensure that children with venous blood lead levels 15 µg/dL or greater are provided risk assessment services to limit exposure to lead hazards. Assessing agencies are also authorized to conduct lead risk assessments and issue lead hazard reduction orders on a property for any child with a venous blood lead level 5 µg/dL or greater, as resources allow. Current assessing agencies in Minnesota are MDH, the City of Minneapolis Health Department and St. Paul-Ramsey County Public Health. MDH conducts risk assessment for children outside of Minneapolis and Ramsey County.

In 2016, there were 85 children newly identified with venous confirmed EBLLs ≥ 15 µg/dL. Fifteen of these children lived in Minneapolis, 22 in Ramsey County, and 48 elsewhere in Minnesota. Forty six of the 85 (54%) received a lead risk assessment within 10 working days of the blood lead test being reported to MDH and 78 (92%) received an assessment within 90 working days. Seven cases have not received a risk assessment at the time of this analysis. These cases may not have received a risk assessment for reasons such as having no permanent residence or inability of the risk assessing agency to locate the case. The median number of working days between the EBLL being reported to MDH and the risk assessment was 10 days (Interquartile range: 7, 14).

The 85 15+ µg/dL EBLL children tended to have common risk factors for lead exposure. Eighty-eight percent lived in homes built prior to 1978 and 72% lived in homes built prior to 1950. Forty-one percent lived in Minneapolis or St. Paul. Twenty percent had recently immigrated to U.S. and may have been exposed in their countries of origin and/or refugee camps.

Many of the ≥ 15 µg/dL EBLL cases had previously been identified as having an EBLL in the 5–14.9 µg/dL range. Fourteen of 85 (16%) had a venous-confirmed EBLL in the 5–14.9 µg/dL range more than one month prior to the ≥15 µg/dL test result. These represent opportunities for earlier intervention, where lead hazards likely could have been removed prior to the blood lead level rising over 15 µg/dL if there had been greater resources to conduct risk assessments at lower elevated blood lead levels.

[9] Centers for Disease Control and Prevention. (1997). Capillary Blood Sampling Protocol (PDF).

During the lead risk assessments, lead hazards were identified for 85% of children (66 of 78 receiving an assessment). Many children had multiple hazards identified. Lead-based paint and/or lead contaminated indoor dust was identified as a possible source of lead exposure for 58 cases. Indoor dust is commonly contaminated by deteriorating lead-based paint in the house. Lead soil hazards, measured by laboratory analysis of soil samples, were identified at the residences of 26 cases. Other hazards, including contaminated spices, contaminated cultural or religious items such as sindoor powder, swallowed lead-containing metallic objects, and take-home occupational lead contamination from an adult household member, were identified among 12 cases.

Not all types of potential hazards are tested during every risk assessment. For example, soil was not tested if there was no bare soil the child could have been exposed to. In addition, hazards tested and identified during a risk assessment are not systematically reported to the MDH Lead Program and some hazards tested and identified may be underreported. However, the figures presented in Table 3, interpreted as 'ballpark' estimates, suggest that lead based paint and/or dust hazards are tested during the majority of risk assessments, at least 69 of 78 (88%), and these hazards are identified most of the time that they are tested for (58 of 69, 84%). Soil hazards are tested less frequently, with results reported with 34 of 78 (44%) assessments, but are commonly identified when soil is tested (26 identified among 34 tested, 76%). Other hazards are tested less frequently, reported with 13 of 78 (17%) risk assessments. Testing for lead-contaminated drinking water was not reported with any of the 78 risk assessments in 2016.

When multiple hazard types were tested in a home, multiple types of hazards tended to be identified. During 41 assessments where multiple hazard types (paint/dust, soil, water and/or other) were tested, more than one hazard type was identified in 28 cases (68%). This suggests that it may be common for children with elevated blood lead levels of 15+ µg/dL to be exposed to multiple sources of lead contamination. Testing all possible sources, even after one hazard or type of hazard is identified, may help in creating a lead-safe environment for the child.

Table 3. Lead Hazards Assessed and Identified during Lead Risk Assessments for Children with EBLLs ≥15 µg/dL in 2016 (n=78)

Lead Hazard Type	Tested	Hazard Identified, n (%)
Lead-based paint and/or lead contaminated indoor dust	69	58 (84%)
Outdoor contaminated soil	34	26 (76%)
Contaminated drinking water	0	--
Other hazard	13	12 (92%)
Any Hazard Type	73	66 (90%)
Multiple Hazard Types*	41	28 (68%)

*Includes paint/indoor dust (as a single type), soil, water, and other.

Adults

In adults, lead exposure can lead to increased risk for chronic diseases such as hypertension and kidney disease. The Adult Blood Lead Epidemiology and Surveillance (ABLES) program is an active surveillance program that follows up on EBLLs reported to BLIS among adults in Minnesota, and ascertains the source of lead exposure. This includes calling healthcare providers to determine the source of an adult's lead exposure, including his or her employer information, job title, known non-occupational lead exposures, and pregnancy status. The National Institute for Occupational Safety and Health (NIOSH), CDC, and the State of Minnesota use a reference value of 5 µg/dL in adults, as well as children. MDH reports work-related blood lead levels of 25 µg/dL or greater to Minnesota Occupational Safety and Health Administration (MNOSHA) so MNOSHA can investigate the conditions that led to the EBLL. Adult lead testing is most common among people working in high-risk industries and pregnant women with either occupational or non-occupational risk factors for lead exposure.

The total number of BLL tests reported for adults in 2016 in Minnesota is presented in Table 4. There were 10,927 BLL tests performed in 2016 on 9,281 adults (aged ≥ 16 years). Of those 9,281 adults, 4,166 (45%) were men, 5,107 (55%) were women, and 8 had an unreported gender. Pregnancy status was unreported too often for reliable estimates. Of the adults tested, 11% had an EBLL of 5 µg/dL or greater, and of those people, 91% were under 25 µg/dL.

Although more women than men were tested during 2016, 90% of adults with an EBLL of at least 5 µg/dL were men. This was likely due to more men than women working in industries and occupations with high risk for lead exposure. Of the 1,059 adults with BLLs 5 µg/dL or greater, 797 (75%) were fully or partially due to occupational exposures, 41 (4%) were due to non-occupational exposures, and 221 (21%) were due to unknown exposures.

Table 4. Blood Lead Levels among Tested Adult (Aged 16+) Minnesota Residents

2016 BLL Data	BLL < 5 µg/dL	BLL 5-9 µg/dL	BLL 10-24 µg/dL	BLL ≥ 25 µg/dL	Total
Number of BLL Tests	8594	831	1303	199	10,927
Number of individuals tested	8222	468	494	97	9,281
Occupational Exposure	846	289	427	81	1643
Number of Men tested	728	262	409	76	1475
Number of Women tested	118	26	18	5	167
Non-Occupational Exposure	1	3	29	9	42
Number of Men tested	1	3	18	8	30
Number of Women tested	0	0	11	1	12
Unknown exposure source	7375	176	38	7	7596
Number of Men tested	2482	139	35	5	2661
Number of Women tested	4887	36	3	2	4928

EBLLs caused by occupational exposures were analyzed and are reported in Figure 11. Twenty-seven percent of the occupational exposures occurred in the secondary smelting industry, 18% occurred in the sporting and athletic goods manufacturing industry, 6% in the ship building industry, 4% in the recreation industry, and 4% occurred due to work in small arms ammunition manufacturing. Figure 12 displays the EBLL data for work-related exposures by occupation. Twenty-seven percent of adults with occupational exposure had an occupation that worked with some form of machinery, with molders and molding machine setters, operators and tenders making up 11%. Among people with EBLLs from non-occupational sources, shooting firearms as a hobby was the most common source, with casting bullets as the second most common source. The highest EBLL due to a non-occupational exposure was 54 µg/dL, due to a retained bullet.

Figure 11. Work Related EBLLs Greater than or Equal to 5 µg/dL, by Industry

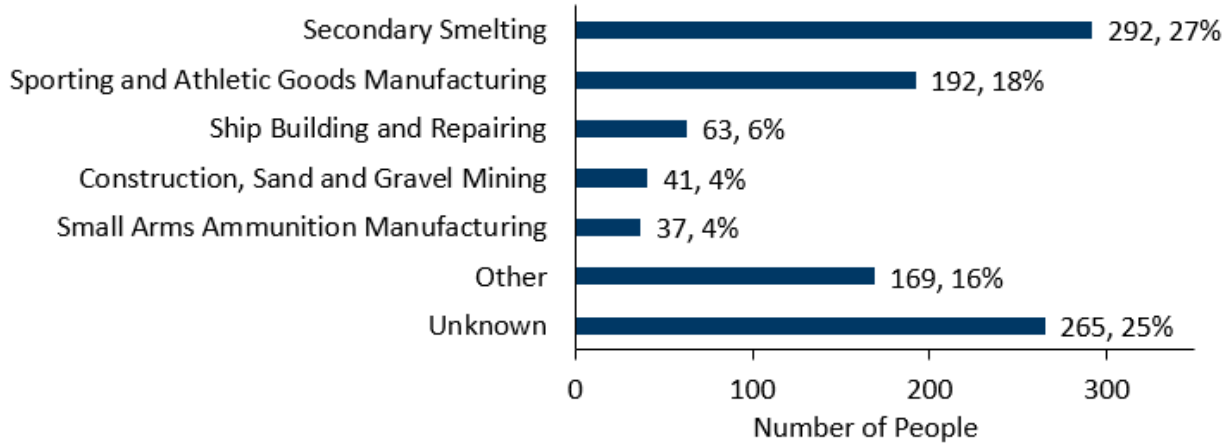
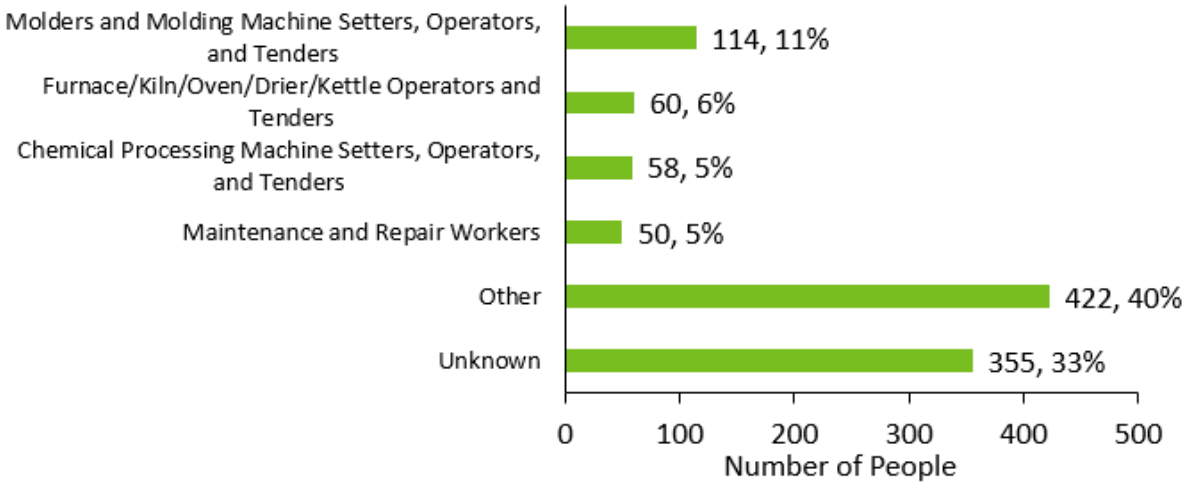


Figure 12. Work Related EBLLs Greater than or Equal to 5 µg/dL, by Occupation



Response to Occupational Lead Exposures at a Shipyard, 2016

In addition to routine surveillance, the LHHP program monitors for and responds to incidents involving lead exposures among large numbers of people when they occur. One such event occurred at a shipyard in Douglas County, Wisconsin where many Minnesota residents were exposed to lead at the workplace. The following report was published earlier this year in the CDC's Morbidity and Mortality Weekly Report (MMWR) and summarizes the magnitude of the exposures and the joint response between the MDH and Wisconsin Department of Health Services.[10]

"On March 28, 2016, the Minnesota Poison Control System was consulted by an emergency department provider regarding clinical management of a shipyard worker with a blood lead level (BLL) >60 µg/dL; the National Institute for Occupational Safety and Health defines elevated BLLs as ≥5 µg/dL.[11] The Minnesota Poison Control System notified the Minnesota Department of Health (MDH). Concurrently, the Wisconsin Department of Health Services (WDHS) received laboratory reports concerning two workers from the same shipyard with BLLs >40 µg/dL. These three workers had been retrofitting the engine room of a 690-foot vessel since January 4, 2016.

Work was suspended during March 29–April 4 in the vessel's engine room, the presumptive primary source of lead exposure. On March 29, the shipyard partnered with a local occupational health clinic to provide testing for workers. Employees and their household members were also tested by general practitioners and local laboratories. The shipyard hired sanitation crews for lead clean-up and abatement and provided personal protective equipment for its employees. On April 1, WDHS and MDH issued advisories to alert regional health care organizations, local public health agencies, and tribal health departments to the situation and launched a joint investigation on April 4. Subsequently, WDHS activated its Incident Command System and worked with MDH to compile a list of potentially exposed workers. By August 31, a total of 357 workers who might have been employed at the shipyard during December 2015–March 2016 had been identified.

During April–July 2016, WDHS and MDH attempted telephone interviews with workers. The goal of the interviews was to gather information regarding employment history, work tasks, personal exposure prevention, symptoms commonly associated with lead exposures, and take-home contamination prevention and household composition and to convey health messages.

As of August 31, a total of 233 (65.3%) of 357 workers received at least one BLL test and 185 (51.8%) completed interviews. Among 233 tested workers (median = 16.0 µg/dL; interquartile range = 4.4–30.6 µg/dL), 171 (73.4%) had BLLs ≥5 µg/ dL, 151 (64.8%) had BLLs ≥10 µg/dL, 33 (14.2%) had BLLs≥40 µg/dL, and two (0.9%) had BLLs ≥60 µg/dL. Among 341 household members identified through worker interviews, 46 (13.5%) received a BLL test; none had an

[10] Weiss D, Yendell SJ, Baertlein LA, et al. Notes from the Field. Occupational Lead Exposures at a Shipyard — Douglas County, Wisconsin, 2016. MMWR Morb Mortal Wkly Rep 2017;66:34.

[11] National Institute for Occupational Safety and Health. Adult Blood Lead Epidemiology & Surveillance. Atlanta, GA: US Department of Health and Human Services, CDC, National Institute for Occupational Safety and Health; 2016.

elevated BLL. Not all exposed workers and household members were tested for lead, and not every BLL test result might have been reported to WDHS or MDH.

At this time, WDHS and MDH have concluded their joint investigation of the shipyard. The Occupational Safety and Health Administration enforcement investigation began on February 10, 2016 because of lead exposure hazards and revealed that shipyard workers were exposed to lead at ≥20 times the reduced permissible exposure limit of 40 µg/m^3.[12] [13]

This investigation highlights timely laboratory-based BLL reporting and efficient interstate collaboration. Moreover, it emphasizes the importance of implementing proper engineering controls and periodic BLL monitoring of employees exposed to lead[14] and providing correct personal protective equipment for workers in the shipbuilding industry[12]."

Evaluation of BLIS

MDH has been consistently improving the Blood Lead Information System (BLIS) through recent years. Improvements have been made in the completeness and timing of the data in the system.

Completeness

Extensive efforts are made by MDH staff to ensure the completeness of data in BLIS. This often involves contacting clinics and laboratories to obtain additional information when incomplete records are submitted to MDH and monitoring submissions from laboratories to detect and remediate any missed submissions. This has resulted in an improvement in the completeness of several variables that are necessary for both surveillance and case response functions of BLIS. The test type (venous or capillary) improved from being undocumented on nearly 10% of records in 2000 to 1% in 2016. Test type is used for case confirmation and initiation of environmental risk assessment services. The completeness of address and phone number fields have also improved substantially. These variables greatly help local public health agencies contact families of lead exposed children to provide public health services. Race and ethnicity would be useful for surveillance, to monitor disparities and identify high-risk populations, if the completeness were further improved. **(Table 5)**.

[12] Occupational Safety Health Administration 2016. Wisconsin shipyard faces nearly $1.4M in OSHA penalties for exposing workers to lead, and other hazards while retrofitting vessel. OSHA National News Release. Washington DC: US Department of Labor.

[13] Occupational Safety Health Administration. Regulations (Standards - 29 CFR). Washington DC: US Department of Labor, Occupational Safety Health Administration; 2016

[14] Association of Occupational and Environmental Clinics. Medical management guidelines for lead-exposed adults revised April 2007 (PDF). CSTE medical management guidelines added October 2013. Washington DC: Association of Occupational and Environmental Clinics; 2016.

Table 5. Completeness of Blood Lead Records Submitted to MDH by Year

Year of Test	Test Type (Ven or Cap) Percent Missing	Race Percent Missing	Hispanic Ethnicity Percent Missing	Residential Address/ City/ZIP Code Percent Missing	Phone Number Percent Missing
2000	9%	43%	76%	11%	39%
2001	15%	46%	76%	9%	35%
2002	13%	46%	71%	6%	30%
2003	3%	45%	66%	6%	26%
2004	3%	43%	61%	7%	24%
2005	2%	40%	57%	9%	23%
2006	3%	37%	52%	9%	22%
2007	3%	37%	51%	7%	18%
2008	2%	37%	51%	6%	18%
2009	2%	36%	48%	5%	19%
2010	1%	37%	48%	4%	19%
2011	2%	36%	50%	2%	23%
2012	3%	34%	56%	2%	25%
2013	1%	35%	58%	2%	17%
2014	2%	35%	59%	2%	23%
2015	2%	32%	59%	1%	16%
2016	1%	34%	55%	1%	12%

Timing

The timing of the data in BLIS is measured by the time between a blood lead test, its submission to MDH, and its entry into BLIS.

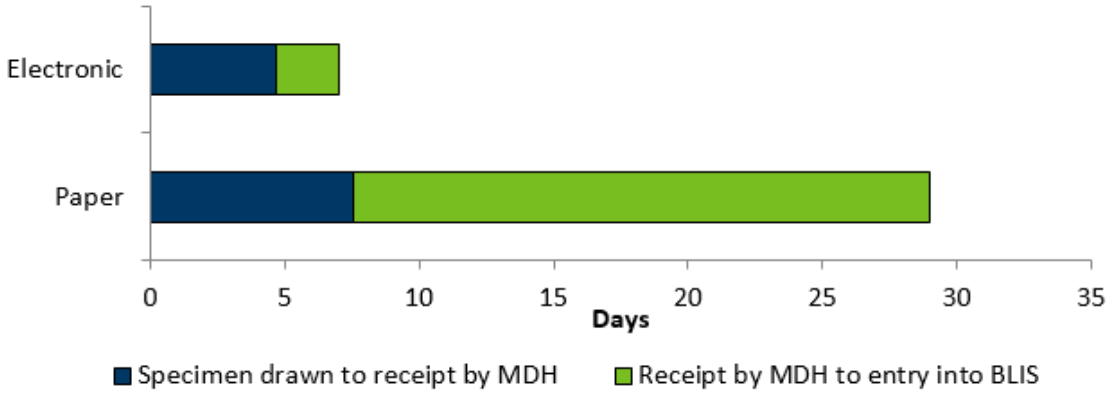
The use of electronic reporting formats allows for greater efficiency in handling large numbers of records. The LHHP works with the Minnesota Electronic Disease Surveillance System (MEDSS) to incorporate electronic reporting of blood lead test results into routine data handling by MDH.

In 2016, there were 110,129 total blood lead tests reported to BLIS, 84% of which were received electronically via secure data connection, encrypted email, or secure web downloads. There were still 18,059 results received by paper reporting through mail or fax. Electronic reporting significantly improves timeliness and requires less staff time for entry of records into BLIS compared to paper reporting. Tests were received primarily from 74 separate laboratories during 2016. Of these, 36 submitted primarily electronic records and 38 submitted primarily paper records.

The median total time from specimen collection to entry into BLIS was 7 days for electronic records during 2016, while the median total time to entry into BLIS for paper records was 29 days. This delay applies to blood lead test results below 5 µg/dL; results at or above 5 µg/dL are separated and entered immediately upon receipt. (**Figure 13**)

Support of the state's capacity to enter all records in a timely manner remains critical to addressing the needs of children who have been exposed to lead. In addition, the infrastructure for electronic laboratory reporting is critical to ensuring a timely public health surveillance system.

Figure 13. Median Timeframes for Electronic and Paper Blood Lead Test Results Reported to BLIS, 2016



Other Resources Available from LHHP

The Lead Program maintains a web page through the MDH Web site that provides a number of lead education materials for providers, regulated parties, and the general public (Lead). This site contains numerous fact sheets, a list of "frequently asked questions", all publications and reports (including guidelines for screening children and pregnant women, case management, and clinical treatment in children), and links to many external lead resources.

M-CLEAN

The Minnesota Collaborative Lead Education and Assessment Network (M-CLEAN) is a workgroup that discusses lead exposure prevention initiatives and legislative developments. Membership is open to all interested stakeholders. Organizations that typically participate in M-CLEAN include MDH, local public health agencies, other governmental agencies, community action agencies, non-profit organizations, and industry groups. More information on Lead Poisoning Prevention: M-CLEAN meetings.

Swab Team Services Grants

MDH has collaborated with community partners through Swab Team Services Grants since 2006. The grants are authorized under Minnesota Statutes 144.9512.

MDH's Swab Team Services Grant provides nonprofit organizations with funding to:

- Increase the screening of children under six years and pregnant women to identify elevated blood lead levels (EBLL) in populations at high risk for lead exposure
- Plan, implement, and execute successful lead screening events in communities with high lead exposure
- Provide education and outreach services when an EBLL is identified
- Provide swab team services to protect populations from identified lead hazards in their residences

Organizations funded by the Swab Team Services Grants during 2016 were Sustainable Resources Center and CLEARCorps USA.

Healthy Homes Information

In addition to lead exposure prevention responsibilities, the LHHP at MDH administers the Healthy Homes Program. This program distributes approximately $240,000 per year in grants to local agencies and organizations as authorized by Minnesota Statutes 144.9513, which defined healthy housing and established healthy housing grants. These grants address lead, asthma, radon, injuries, smoking, excessive moisture/mold, pests, carbon monoxide, fire hazards, and other home-related health hazards. Additional information can be found at Healthy Homes Minnesota program and grants as well as in the Biennial LHHP Legislative Report (PDF).

Further Lead Information

More information about lead exposure prevention in Minnesota is available at the MDH Lead Program web site or by calling 651-201-4620.