DEPARTMENT OF HEALTH

2018 Blood Lead Surveillance Report

LEAD AND HEALTHY HOMES PROGRAM

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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
ESNDC	East Side Neighborhood Development Company
FDA	U.S. Food and Drug Administration
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
MDE	Minnesota Department of Education
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
PPB	Parts per Billion
U.S.	United States
µg/dL	Micrograms of lead per deciliter of whole blood

Executive Summary

This 2018 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 2018 calendar year. The report contains a description of the trends in lead testing and elevated blood lead levels in Minnesota.

In 2018, over 91,000 Minnesota children received at least one blood lead test. Of these, 885 (under 1%) were found to have an elevated blood lead level. 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.

Childhood blood lead screening has improved in Minnesota since 2000. Approximately 81% of children born in 2015 were tested at least once prior to their third birthday in 2018, 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, just over one-third of children receive blood lead tests at both one and two years of age.

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 2018, 78% 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 2018, there were 87 children with confirmed blood lead levels over 15 µg/dL; 76 of these were newly identified. 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 2018, 963 Minnesota adults were found to have elevated blood lead levels. Common industries where workers were exposed in 2018 included secondary smelting, sporting and athletic goods manufacturing (includes fishing sinker manufacturing), and small arms ammunition manufacturing.

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. MDH also contributes to regional and national efforts to formulate strategies for identifying and preventing exposure to lead. MDH currently receives funding from state and federal sources, including funds from the Centers for Disease Control and Prevention (CDC) to support these activities. Ongoing investment is necessary 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 hazards for 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 remains 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 time spent 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. In addition, certain populations are at increased risk of lead exposure. For example, children enrolled in medical assistance programs are more likely to live in old, poorly maintained housing, which is more likely to contain lead paint hazards.[1] 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.[2] Lead exposure is an important environmental justice concern, given these populations who are most at risk.

Lead in Drinking Water

Lead in drinking water is a concern that has received increasing attention nationally, largely due to the crisis in Flint, Michigan. While lead-based paint remains the most common source of lead exposure for children in Minnesota with EBLLs, lead in drinking water is more likely to create a lower-level exposure for a larger population.[3] Efforts toward reducing lead in drinking water are therefore a means of primary prevention of lead exposure.

MDH provides technical assistance to the Minnesota Department of Education (MDE) in testing for and responding to lead in drinking water in schools. In collaboration with MDE, MDH released guidance and a model plan in April 2018 titled *Reducing Lead in Drinking Water: A Technical Guidance and Model Plan for Minnesota's Public Schools*. The plan reflects the commitment of public health, education, and legislative leaders, as well as those directly

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[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). https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5809a1.htm

[2] Zabel EW, Smith ME, O'Fallon A. Implementation of CDC Refugee Blood Lead Testing Guidelines in Minnesota. Public Health Rep. 2008; 123; 111-123. https://www.health.state.mn.us/communities/rih/guide/leadtest.pdf

[3] Zartarian V, Xue J, Tornero-Velez R, Brown J. Children's Lead Exposure: A Multimedia Modeling Analysis to Guide Public Health Decision-Making. Environ Health Perspect. 2017; 125(9):097009.

responsible for operating school drinking water systems, to reduce the chance that children are exposed to the health hazards of lead through school drinking water. It provides information on the required steps in testing and reporting, as well as flexible guidance that schools can consider to meet their individual needs. It also builds on existing guidance that schools have used since 1989 to help develop and implement plans to test for lead in drinking water and communicate results to parents and the public, fulfilling the requirements of a new state law passed in 2017. The plan can be found at Reducing Lead in Drinking Water (https://www.health.state.mn.us/communities/environment/water/docs/pbschoolguide.pdf).

Future MDH efforts to address lead in drinking water will include assisting with testing for lead in drinking water in schools and day care facilities, creating policies and procedures for the replacement of lead service lines, and increased coordination across lead poisoning prevention partners.

Elevated Blood Lead Levels

The Centers for Disease Control and Prevention's current reference level for an elevated blood lead level is 5 micrograms of lead per deciliter whole blood (µg/dL). 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.

State Blood Lead Guidelines

MDH has a set of four guidelines available for lead: Childhood Blood Lead Case Management, Blood Lead Screening for Pregnant Women, Childhood Blood Lead Screening, and Childhood Blood Lead Clinical Treatment, which may be found at MDH Blood Lead Level Guidelines (https://www.health.state.mn.us/communities/environment/lead/prof/guidelines.html). 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.

Childhood Blood Lead Screening Guidelines

REVISED MARCH, 2011

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

- Children residing in specific geographic areas that have high rates of elevated blood lead
- 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 or other forms of Medical Assistance. 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 Routine Blood Lead Screening Risk Questionnaire (https://www.health.state.mn.us/communities/environment/lead/docs/riskquestionnaire.pdf) to help determine if a child is at high risk for lead exposure.

Childhood Blood Lead Case Management Guidelines

REVISED DECEMBER, 2017

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, as well as information on the case manager's role, environmental risk assessments, home visits, sources of lead, referrals, and resources. The *Childhood Blood Lead Case Management Guidelines for Minnesota* was first released in 2001. The *2017 Revision* was updated based on national recommendations, changes to the elevated blood lead level definition (≥5 µg/dL), and input from a multi-disciplinary workgroup. In addition to the reference manual, there is also an accompanying *Childhood Blood Lead Case Management Guidelines Summary*, a two-page summary document for a quick verification of intervention recommendations for each blood lead level.

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 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 for all blood lead levels. Additional diagnostic tests and interventions, such as developmental assessments, iron studies, radiographs, additional bloodwork, and chelation therapy, are recommended at different levels of elevated blood lead levels. A multi-disciplinary workgroup was formed in 2018 to review existing literature and provide recommendations and feedback for updating the treatment guidelines. An updated revision to the Childhood Blood Lead Clinical Treatment Guidelines is expected in 2019.

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 2015, 81% were tested at least once by their third birthday in 2018.

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 60% of elevated capillary screening tests may be false positives.[4] 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.

[4] Wang A, Rezania Z, Haugen K, Baertlein L, Yendell S. Screening for Elevated Blood Lead Levels: False-Positive Rates of Tests on Capillary Samples, Minnesota, 2011–2017. J Public Health Manag Pract. 2019; 25(Suppl. 1): S44–S50.

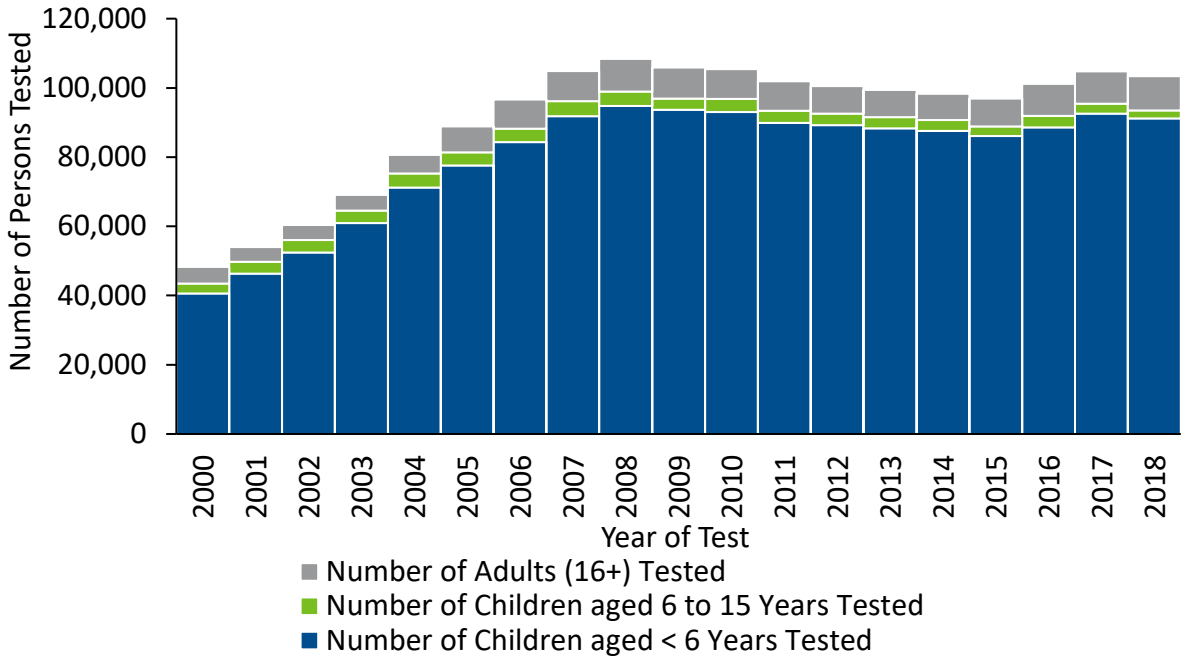
Statewide Surveillance Data

Statewide data are available starting from 1995. Data for years 2000–2017 are shown for comparison to the 2018 data. The number of children tested for lead in Minnesota increased steadily from 2000 through 2008, decreased slightly during 2009–2015, and increased again in 2016 and 2017. In 2018, 91,175 children aged less than 6 years were tested (**Figure 1**).

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 2018, 2,287 children aged 6 to 15 years received a blood lead test.

Adults are tested for blood lead primarily 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 2018, 9,885 adults (aged 16+) were blood lead tested.

Figure 1. Number of Persons Blood Lead Tested by Year and Age Group, Minnesota, 2000–2018.

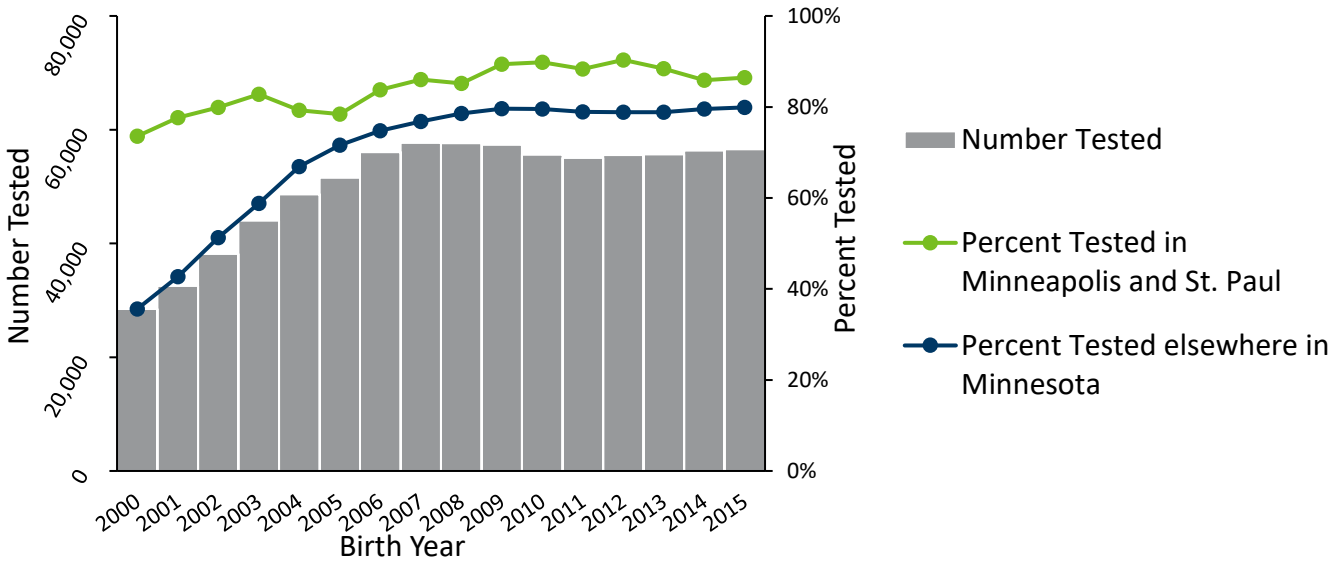


Childhood Blood Lead Screening

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 given 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.

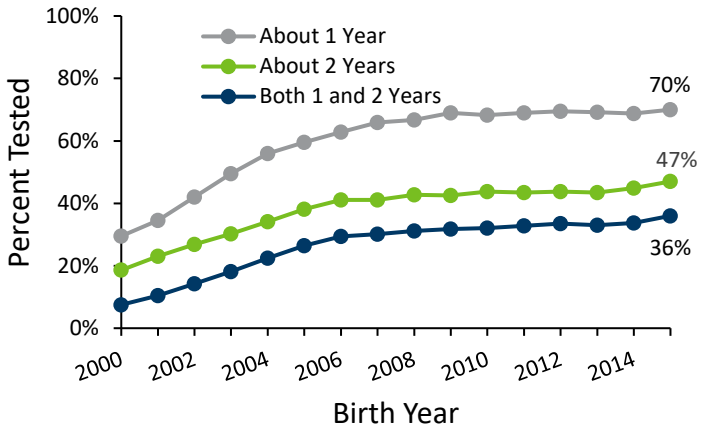
The most recent birth cohort to have been observed for a full three years is children born in 2015. Among the 69,835 children born in 2015, 56,536 children (81%) statewide were tested at least once by age three years. Among children in Minneapolis and St. Paul, where universal screening is recommended, 86% were tested at least once. Elsewhere in the state, 80% were tested at least once. (**Figure 2**)

Figure 2. Number and Percent of Children Tested at Least Once by Age 3 Years, by Birth Cohort



Within the 2015 birth cohort, while 81% of children were tested at least once by age three, 70% were tested around one year of age (9 to 18 months), 47% were tested around two years of age (18 to 36 months), and only 36% were tested at both one and two years of age (**Figure 3**). This indicates that many providers are testing children at one year but not two years of age.

Figure 3. Children Tested at 1-Year and 2-Years of Age, by Birth Year



Two-year-old children are more mobile and interact with their environments differently than

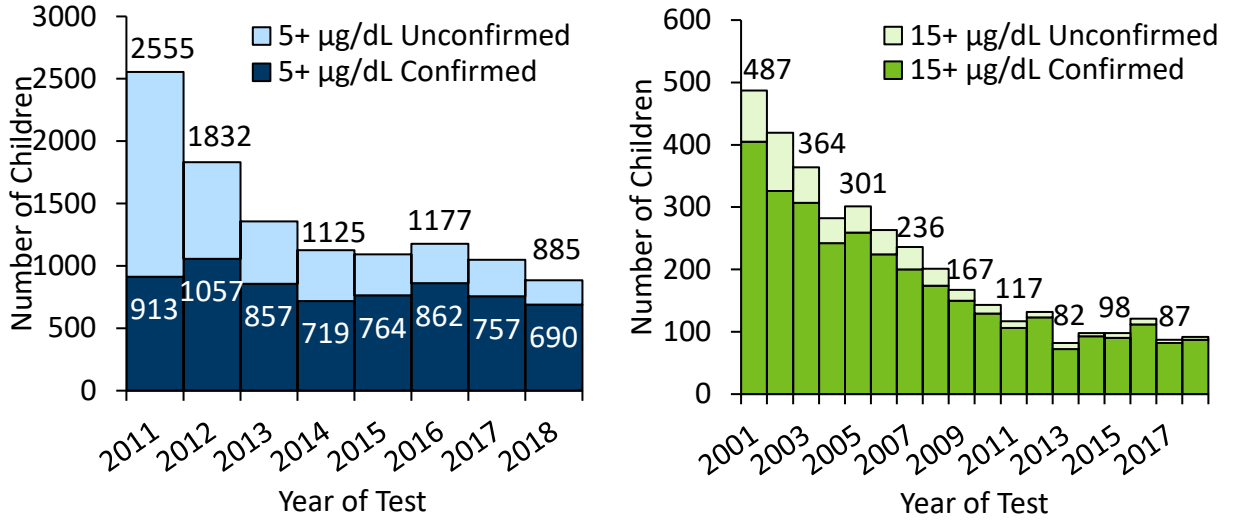
one-year-old children. This can change the risk for lead exposure between these ages, even if the child's house or other risk factors do not change.
This is supported by MDH surveillance data; about 0.5% of children with non-elevated (<5 µg/dL) blood lead levels measured at one year of age who were tested 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.

Blood lead screening statistics are available at the county scale through the MDH Data Access Portal's Childhood Lead Exposure (https://data.web.health.state.mn.us/web/mndata/lead) 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 4**). The number of EBLL cases has continued to decrease in recent years. However, in 2018, there were still 690 Minnesota children who had confirmed blood lead levels of at least 5 µg/dL, 87 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 2018 was 73 µg/dL.

Figure 4. Number of Children with Confirmed and Unconfirmed Elevated Blood Lead Levels (5+ µg/dL and 15+ µg/dL) by Year of Test, 2001–2018

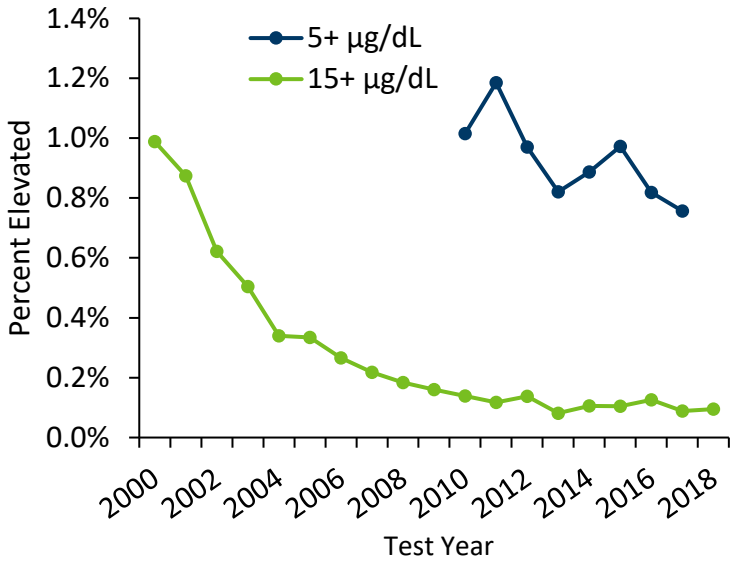


A confirmed elevated blood lead level is defined here as any elevated venous blood lead test result or any elevated capillary blood lead test result followed-up by a second elevated capillary test within 12 weeks.[5] An unconfirmed elevated blood lead level is an elevated capillary blood

[5] Centers for Disease Control and Prevention (CDC). Standard Surveillance Definitions and Classifications for Lead. https://www.cdc.gov/nceh/lead/data/definitions.htm. Retrieved 6/28/2018.

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 2018, for levels 5 µg/dL or greater, this would be somewhere between 690 and 885. In 2018, 91,175 children were blood lead tested and 690 (0.8%) had a confirmed EBLL of 5 µg/dL or greater while 87 (0.1%) had a confirmed EBLL of 15 µg/dL or greater (**Figure 5**).

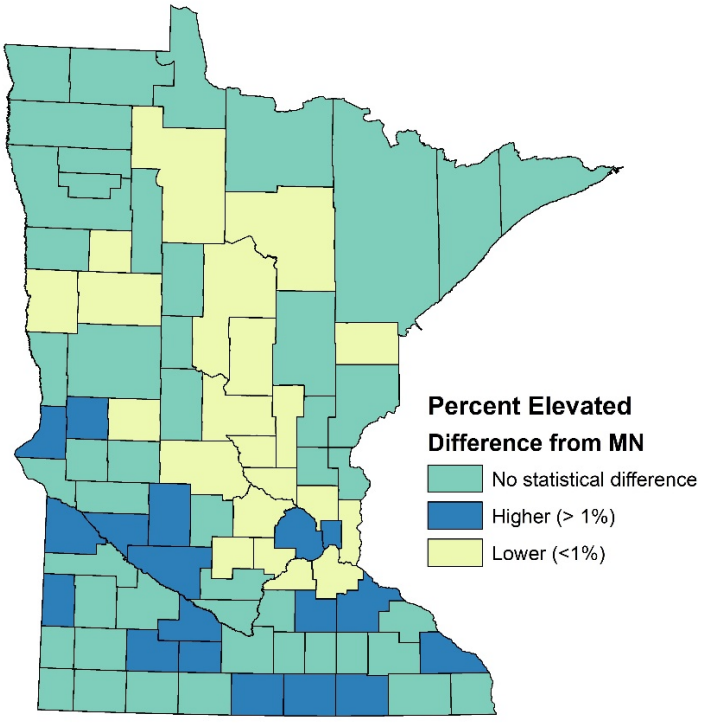
Figure 5. Percent of Children with Confirmed Elevated Blood Lead Levels by Year, Among Tested Children, 2000–2018



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 higher percentages of children are found to have EBLLs. To estimate the percent EBLL at county and sub-county geographic scales, five years (2014–2018) of blood lead testing data were compiled to increase estimate precision. Statewide, the percentage of children tested with a confirmed EBLL was just under 1%. At the county level, the percentage of children tested with confirmed EBLLs ranged from 0% to nearly 4%. Counties with EBLL rates that were statistically significantly higher than the statewide percent EBLL were found in the southern half of the state and included Hennepin and Ramsey counties. (**Figure 6**)

Figure 6. Elevated Blood Lead Levels (5+ µg/dL) by County, Among Children Tested, 2014–2018



The majority of high percent-EBLL census tracts are found in the cities of Minneapolis and St. Paul, but can also be found in rural areas of the state. Tracts with higher percent-EBLL tend 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.

Additional county-level and tract-level data regarding blood lead testing and the distribution of EBLLs among Minnesota children are available on the MDH Data Access Portal's Childhood Lead Exposure (https://data.web.health.state.mn.us/web/mndata/lead) page.

Demographics

The demographic indicators sex, race and ethnicity are collected by MDH with blood lead test results. While the reporting of sex 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". Data on sex 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 2018, blood lead test results for children aged less than six years were reported for 46,293 males, 43,849 females, and 46 persons for whom sex was not reported. The percentage of confirmed EBLLs was not significantly different between males and females (**Table 1**).

Table 1. Summary of the Reported Demographic Characteristics of Children Aged < 6 Years Blood Lead Tested in 2018 and EBLL Cases (Confirmed ≥5 µg/dL)

Demographic	Tested, n (%)	EBLL Cases, n	Percent EBLL
Sex			
Female	43,849 (49%)	332	0.8%
Male	46,293 (51%)	358	0.8%
Unknown	46 (0%)	0	0%

Racial and ethnic disparities in the prevalence of lead poisoning have been shown in national data. A 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.[6] Individual race and ethnicity data reported with blood lead tests is too incomplete to provide reliable estimates of racial and ethnic disparities in Minnesota, however, the LHHP is working to improve data completeness (see *Evaluation of BLIS* section of this report).

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.[7] However, this disparity may differ between states and the CDC has recommended states develop screening plans consistent with their local risk patterns.[8] A study of Minnesota blood lead surveillance data 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 was similar to the national disparity, with an approximately 2-fold difference in prevalence.[9] 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.

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[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. https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6213a3.htm

[7] 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. https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6213a3.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). https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5809a1.htm

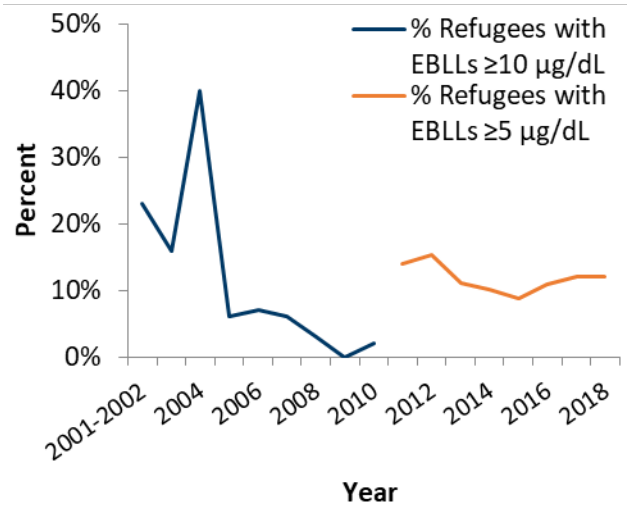
[9] Centers for Disease Control and Prevention (CDC). Recommendations for Blood Lead Screening of Medicaid-Eligible Children Aged 1-5 Years: an Updated Approach to Targeting a Group at High Risk. MMWR Morb Mortal Wkly Rep. 2009; 58(RR-9). https://www.ncbi.nlm.nih.gov/pubmed/16764420

The MDH LHHP and the Minnesota Department of Human Services (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 as well as further exposure once they arrive in the United States. The Division of Infectious Disease Epidemiology, Prevention, and Control at MDH collects demographic data on refugee children aged under 17 years entering the state who receive an initial health screening. Blood lead tests are routinely matched to refugee information (**Figure 7**). The rate of elevated blood lead levels for refugees is over ten times higher than the percentage of elevated blood lead levels among Minnesota children in general.

Figure 7. Elevated Blood Lead Levels (EBLLs) among Refugee Children Who received a Blood Lead Test



Case Management

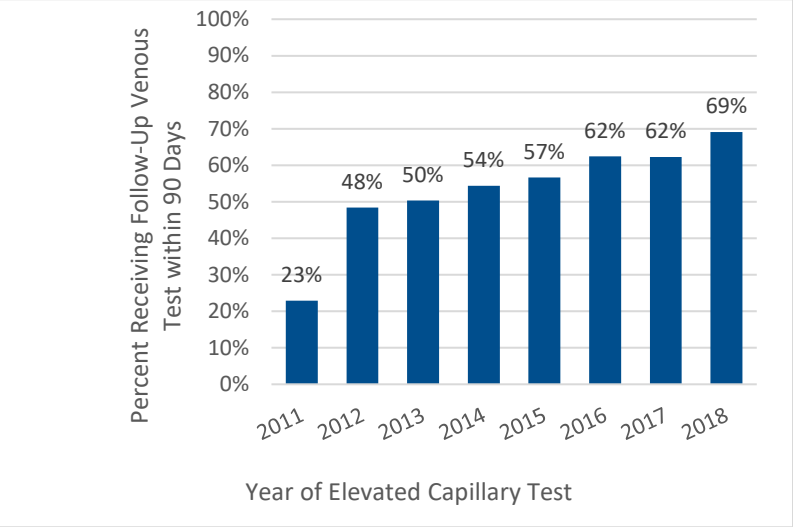
The LHHP provides technical assistance and coordinates with local public health agencies in the state of Minnesota to ensure case management services are available for children with blood lead levels of at least 5 µg/dL. These activities include:

- 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 958 Minnesota children whose first elevated blood lead level was a capillary test in 2018, 662 (69%) received a follow-up venous test within 90 days (Figure 8). 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 8. 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 that is below 5 µg/dL within 90 days. In 2018, 385 (58%) of the 662 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.[10]

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 does this prevent further exposure to the child who has already been exposed, it also prevents 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. Agencies currently performing assessments in Minnesota are MDH, the City of Minneapolis Health Department and St. Paul-Ramsey County Public Health. MDH conducts risk assessments for other assessing agencies through contractual agreements, servicing children outside of Minneapolis and Ramsey County.

In 2018, there were 76 children newly identified with venous confirmed EBLLs ≥ 15 µg/dL. Seventeen of these children lived in Minneapolis, 17 in St. Paul (Ramsey County), and 42 elsewhere in Minnesota. Forty-nine of the 76 (64%) received a lead risk assessment within 10 working days of the blood lead test being reported to MDH and 73 (96%) received an assessment within 60 working days. The remaining three cases have not received a risk assessment at the time of this analysis. These cases have not received a risk assessment for reasons such as lack of a permanent residence and inability of the risk assessing agency to access the property. The median number of working days between the EBLL being reported to MDH and the risk assessment was 8 days.

The 76 15+ µg/dL EBLL children tended to have common risk factors for lead exposure. Ninety-six percent lived in homes built prior to 1978 and 70% lived in homes built prior to 1950. Forty-five percent lived in Minneapolis or St. Paul. Six children had recently immigrated to U.S. and may have been exposed in their countries of origin and/or refugee camps.

Several of the ≥ 15 µg/dL EBLL cases had previously been identified as having an EBLL in the 5–14.9 µg/dL range. Ten of 76 (13%) 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, not including two cases with known EBLLs who moved to Minnesota from other states. These cases 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.

During the lead risk assessments, lead hazards were identified for 82% of children (60 of 73 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

[10] Centers for Disease Control and Prevention. (1997). Capillary Blood Sampling Protocol. Retrieved from https://www.cdc.gov/nceh/lead/publications/1997/pdf/c2.pdf

52 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 21 cases. Other sources of lead were identified among 9 cases, including contaminated spices, contaminated cultural or religious items such as sindoor powder, ceramic bean pots, and keys.

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. The figures presented in **Table 2**, interpreted as 'ballpark' estimates, show that lead based paint and/or dust hazards are tested during the majority of risk assessments (100% in this sample), and these hazards are present most of the time that they are tested (52 of 73, 71%). Soil hazards are tested less frequently, with results reported for 39 of 73 (53%) assessments, but are commonly identified when soil is tested (21 identified among 39 tested, 54%). Other hazards are tested less frequently, most often when lead based paint hazards are not identified. In 2018, they were reported with 15 of 73 (21%) risk assessments.

Table 2. Lead Hazards Assessed and Identified during Lead Risk Assessments for Children with EBLLs ≥15 µg/dL in 2018 (n=73)

Lead Hazard Type	Tested	Hazard Identified, n (%)
Lead-based paint and/or lead contaminated indoor dust	73	52 (71%)
Outdoor contaminated soil	39	21 (54%)
Contaminated drinking water	2	0 (0%)*
Other lead source	15	9 (60%)
Any Hazard Type	73	60 (82%)
Multiple Hazard Types†	48	22 (46%)

*Hazards in drinking water are shown in the table according to the EPA action level of 15 ppb. A detectable level of lead was found in two risk assessments; both were at concentrations less than 15 ppb.

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

Drinking water is not routinely tested during risk assessments. In 2017, MDH did include routine testing of drinking water during risk assessments, however, all tests completed were found to be below the EPA action level of 15 parts of lead per billion parts of water (ppb) for public water systems. A public water system has to take actions to reduce the amount of lead in the water if more than 10 percent of the water samples have lead levels over 15 ppb. This is an action level; there is no safe level of lead in water. Obtaining a water sample that truly captures its potential lead level can be difficult, as ideally the faucet would not be used for 6 hours prior to sampling. For more information on lead in drinking water, see pages 7–8 of this report.

Multiple types of lead hazards were often identified in homes. During 48 risk assessments where multiple hazard types (paint/dust, soil, water and/or other) were tested, more than one

hazard type was identified in 22 cases (46%). 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 as part of a comprehensive risk assessment, even after one hazard or type of hazard is identified, may help in creating a lead-safe environment for the lead-exposed child and other children in that environment.

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 2018 in Minnesota is presented in **Table 3**. There were 11,434 BLL tests performed in 2018 on 9,716 adults (aged ≥ 16 years). Of those 9,716 adults, 4,217 (43%) were men and 5,499 (57%) were women. Pregnancy status was unreported too often for reliable estimates. Of the adults tested, 10% had an EBLL of 5 µg/dL or greater, and of those people, 92% were under 25 µg/dL.

Although more women than men were tested during 2018, 91% 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 963 adults with BLLs 5 µg/dL or greater, 771 (80%) were fully or partially due to occupational exposures, 84 (9%) were due to non-occupational exposures, and 108 (11%) were due to unknown exposures.

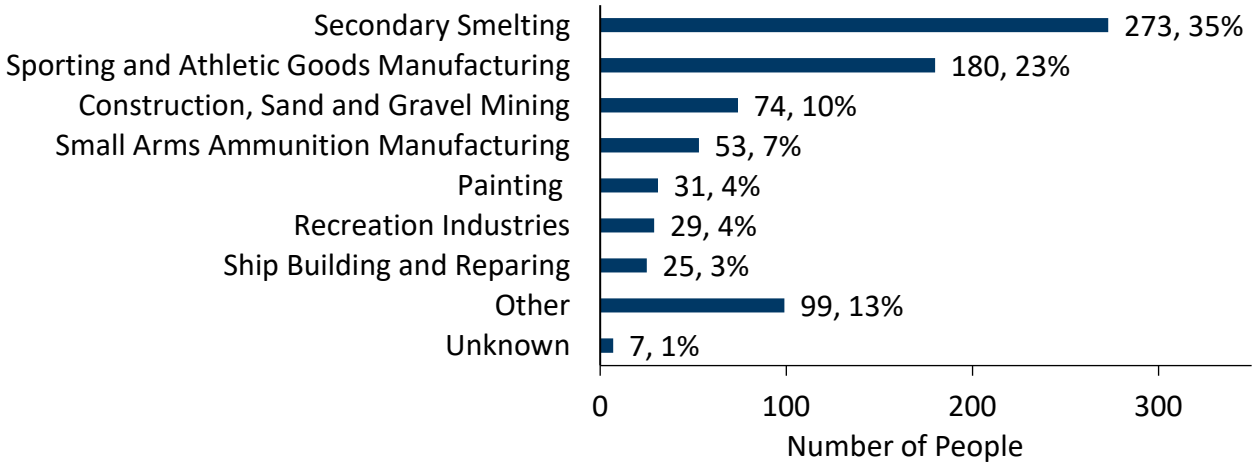
Table 3. Blood Lead Levels among Tested Adult (Aged 16+) Minnesota Residents

2018 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	9,392	824	1,091	127	11,434
Number of individuals tested	8,753	453	437	73	9,716
Occupational Exposure	1,194	331	374	66	1,965
Number of Men tested	1,020	306	360	65	1,751
Number of Women tested	174	25	14	1	214
Non-Occupational Exposure	41	47	32	5	125
Number of Men tested	16	33	24	1	74
Number of Women tested	25	14	8	4	51
Unknown exposure source	7,518	75	31	2	7,626

2018 BLL Data	BLL < 5 µg/dL	BLL 5-9 µg/dL	BLL 10-24 µg/dL	BLL ≥ 25 µg/dL	Total
Number of Men tested	2,300	65	25	2	2,392
Number of Women tested	5,218	10	6	0	5,234

EBLLs caused by occupational exposures were analyzed and are reported in **Figure 9**. Thirty-five percent of the occupational exposures occurred in the secondary smelting industry, 23% occurred in the sporting and athletic goods manufacturing industry, and 10% occurred in construction, sand and gravel mining work. Other occupational exposures included small arms ammunition manufacturing, work in recreation industries, and contracted painting. 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 101.5 µg/dL in an individual whose source of exposure was lead-containing supplements.

Figure 9. Work Related EBLLs (≥ 5 µg/dL) by Industry



Evaluation of BLIS and LHHP

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. In addition, reevaluation of processes within the LHHP is ongoing to assess the use of resources and its value to stakeholders.

Completeness of Data

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. These efforts have 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) has improved from being undocumented on nearly 10% of records in 2000 to 0.2% in 2018. 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 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 4**).

Table 4. 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%	55%	2%	25%
2013	1%	35%	58%	2%	17%
2014	2%	34%	59%	2%	23%
2015	2%	31%	58%	1%	16%
2016	1%	32%	52%	1%	12%
2017	0%	32%	49%	1%	10%
2018	0%	33%	49%	1%	9%

Timing of Data

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 2018, there were 110,170 total blood lead tests reported to BLIS, 88% of which were received electronically via secure data connection, encrypted email, or secure web downloads. Although the majority of test results were received electronically, there were still 13,678 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. The average total time from specimen collection to entry into BLIS was 13 days for electronic records during 2018, while the average total time to entry into BLIS for paper records was 28 days. This total time applies to blood lead test results below 5 µg/dL; results at or above 5 µg/dL that must be manually entered are separated and entered immediately upon receipt. (**Figure 10**) The LHHP continues to work with laboratories to increase their capacity to submit results electronically. In recent years there has been a general upwards trend in the percentage of results received electronically by the LHHP (**Figure 11**).

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 10. Average Timeframes for Electronic and Paper Blood Lead Test Results Reported to BLIS, 2018

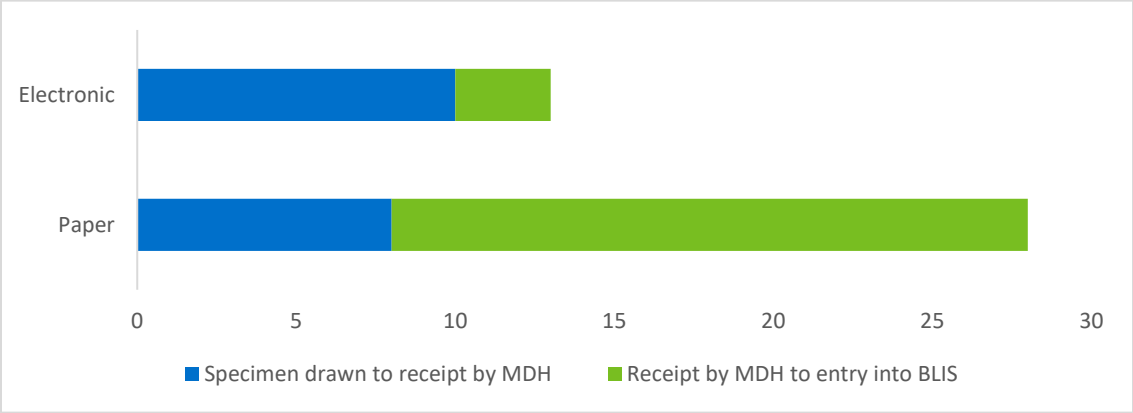
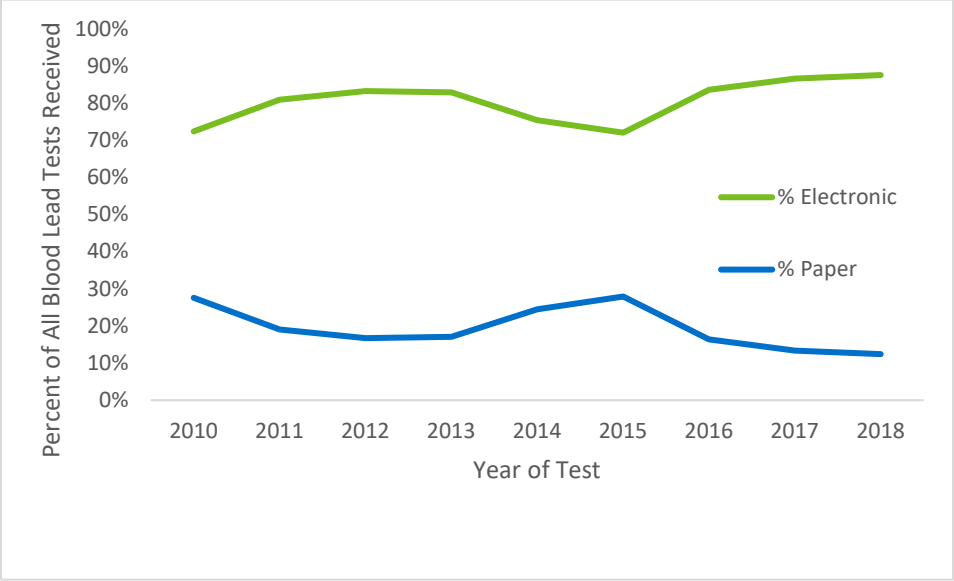


Figure 11. Percentages of Electronic and Paper Blood Lead Test Results by Year



Process Evaluation

In April 2018, staff from the LHHP came together in a Kaizen event to evaluate the case management process for individuals with EBLLs. The purpose of the exercise was to identify inefficiencies and gaps in the process and to determine solutions to those problems. Goals of the project included a decrease in the total time from determination of an EBLL through the final lead clearance inspection, improved internal and external communication throughout the process, and the identification of clear deliverables towards an improved future process. As a result of the Kaizen event, communication within the program and with external stakeholders has improved, processes and business needs have been documented, and staff have been cross-trained to eliminate single-person dependencies. The Kaizen team continues to work toward achieving their outlined future state process.

MDH also met with partners from various local public health agencies in a series of four listening sessions in the spring of 2018. These sessions offered an opportunity for external partners to provide feedback on how MDH could meet their needs related to blood lead surveillance, education, and case management. The open discussion was valuable; agencies were able to discuss the challenges and trends they faced in following up on EBLLs. Listening sessions were held in Duluth, St. Paul, Mankato, and Brooklyn Park.

Other Resources Available from LHHP

The Lead Program maintains a Lead (www.health.state.mn.us/lead) web page through the MDH web site that provides a number of lead education materials for providers, regulated parties, and the general public. 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 meets semiannually to discuss various sources of 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 M-CLEAN meetings can be found at Lead Poisoning Prevention: M-CLEAN (Minnesota Collaborative Lead Education and Assessment Network) (https://www.health.state.mn.us/communities/environment/lead/prof/mclean.html).

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 2018 were Sustainable Resources Center and CLEARCorps USA in Minneapolis and East Side Neighborhood Development Company (ESNDC) in St. Paul. The CLEARCorps USA grant is managed by ESNDC, which acquired CLEARCorps USA in summer 2018.

Healthy Homes Information

In addition to lead exposure prevention responsibilities, the LHHP at MDH administers the Healthy Homes Program. This program distributes $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 on the Healthy Homes program and grants can be found at Healthy Homes Minnesota (https://www.health.state.mn.us/communities/environment/healthyhomes) as well as in the MDH Lead Poisoning Prevention Programs Biennial Report (https://www.health.state.mn.us/communities/environment/lead/docs/reports/bienniallegrept.pdf) to the MN Legislature.

Further Lead Information

More information about lead exposure prevention in Minnesota is available at the MDH Lead (https://www.health.state.mn.us/lead) program web site or by calling 651-201-4620.