2018 Annual Data Report
on
Childhood Blood Lead Testing in Michigan

Issued June 15, 2021

Prepared by

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Executive Summary

This report summarizes data on blood lead testing and elevated blood lead levels throughout Michigan for use by the public, public health professionals, and researchers. The State of Michigan defines an elevated blood lead level (EBLL) as 5 micrograms per deciliter of blood (µg/dL) or higher, as recommended by the CDC's Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP).[1,2] This report focuses on testing in 2018, with comparison to years 2003 through 2017.

Note: This report does not present an analysis of blood lead data for children in Flint beyond that which is presented for the state as a whole and for individual counties, selected communities, and ZIP codes. For more information about Flint, see Michigan.gov/Flintwater.

Key Findings

- In 2018, 142,387 children younger than 6 years old had a blood lead test. This represents 20.8% of the population in this age group.
  - 2.9% (4,124) of these children had an EBLL.
  - 55.3% (2,406) of elevated results were from venous blood tests, the most accurate type of test.
- More children under age 6 were tested and had an EBLL in Detroit than in any county or any other selected community in Michigan, with 1,407 (7.0%) having an EBLL.
- Highland Park had the highest EBLL percent of any selected community, at 14.8% (46 children).
- The top three counties with the highest numbers of children under 6 with an EBLL were:
  1. Kent County (330 children);
  2. Wayne County excluding Detroit (311 children); and
  3. Oakland County (214 children).
- The top three counties with the highest percent of tested children under 6 years with an EBLL were:
  1. Branch County (6.7%, 25 children);
  2. Muskegon County (5.8%, 154 children); and
  3. Calhoun County (5.8%, 150 children).

Recommendations and Next Steps for MDHHS

Continue work with local health departments and other agencies to:

- Increase the total number of children tested.
- Reduce number of children with an EBLL.
- Support services for children with an EBLL to identify and remove sources of lead, mitigate negative effects of exposure.
- Increase the proportion of children with capillary EBLLs receiving a subsequent confirmatory venous test.

Improve the accuracy and timeliness of the surveillance system by:

- Increasing the number of labs reporting electronically.
- Providing data quality feedback to laboratories.
- Consulting a group of CLPPP data users and stakeholders to improve reports.
- Continuing to streamline and improve the analysis process.

Definitions*

Abatement - Work done to remove or cover lead paint in a home. Abatement includes replacing windows and covering lead paint surfaces with a sealer ("encapsulation") among others. It is either permanent or meant to last a long time.

Anemia - Having less than the normal amount of red blood cells in your blood. Anemia can make someone tired and short of breath. It can also make it easier for someone to get lead poisoning.

Blood Lead Level - The amount of lead in a person's blood when they had their blood drawn.

Blood Lead Tests - A test to find out how much lead is in the blood. A small amount of blood is taken from the finger or arm. A blood lead test lets us know if a child has been exposed to lead.

Capillary Blood Sample - A small amount of blood taken from the finger to test for lead, sometimes called a "finger stick."

Chelation - A medical treatment used to remove lead from the body when blood lead levels are very high. Chelation therapy uses drugs that bind to metals in the blood. Once this happens, the metal is then removed from the body through urination.

Elevated Blood Lead Level (EBLL) - A blood lead level of 5 µg/dL or higher (results 4.5 – 4.9 µg/dL are rounded up and considered an elevated result). Elevated means high or raised. Elevated blood lead level is sometimes written as EBLL. See Meaning of an Elevated Result and More about Rounding and the Limit of Detection in the Technical Appendix for more information.

Lead - A metal that can harm the body. Specifically, it can harm brain development in children. Lead can be in paint, pipes and plumbing fixtures, dishes, pottery, toys, jewelry, candy, and folk medicine. It can also be found in many industries like auto repair, construction, and plumbing.

Lead Dust - Tiny bits of lead that are sometimes too small to see. When old paint peels and cracks, it makes lead dust. Home repair projects can also make lead dust. If children breathe in or swallow lead dust, they can get very sick.

Limit of Detection (or limit of reporting) **-** Laboratory blood lead testing has limits on how much lead it can measure in the blood. Different types of tests have different limits. For example, point-of-care (fingerstick) testing has a lower limit of detection of 3.3 µg/dL. A result below this will be recorded as <3.3 µg/dL, meaning the actual blood lead level is lower than the machine can accurately measure, but it is not necessarily zero.

Micrograms per deciliter (µg/dL) - The amount of lead in the blood. For example: A blood lead level of 14 µg/dL means that there were 14 micrograms of lead per deciliter of blood.

Nursing Case Management (NCM) - Helping families of children with elevated lead levels. Case management is done by a nurse, generally from a local health department. It may include helping someone get their home inspected (professionally checked) for lead or go back to the doctor for another blood lead test.

Solder - Metal that is melted and used to connect other pieces of metal together. For example, plumbers may use solder to connect pipes. Some solder is made from lead.

Venous Blood Sample - A small amount of blood taken from a vein in the arm to test for lead.

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* Definitions were modified from CDC's Lead Poisoning Words to Know from A to Z, which has been archived[3]

Report Abbreviations

BLL: Blood Lead Level

CDC: Centers for Disease Control and Prevention

CLPPP: Childhood Lead Poisoning Prevention Program

CMS: U.S. Centers for Medicare and Medicaid Services

EBLL: Elevated Blood Lead Level ($\geq$ 5 µg/dL of lead in the blood)

MCIR: Michigan Care Improvement Registry

MDHHS: Michigan Department of Health and Human Services

MiCLPS: Michigan Childhood Lead Poisoning Surveillance data management system

NCM: Nursing Case Management

ACS: The American Community Survey conducted by the U.S Census Bureau

NVSS: National Vital Statistics System

Introduction

The MDHHS Childhood Lead Poisoning Prevention Program

The MDHHS Childhood Lead Poisoning Prevention Program (CLPPP) began in 1992 and was formalized into state law in 1998 under Michigan's Public Health Code MCL 333.5474.[†] The mission of CLPPP is to prevent childhood lead poisoning across the state through surveillance, outreach, and health services.

Health Hazards of Lead

According to the CDC's Advisory Committee on Childhood Lead Poisoning Prevention, there is no safe level of lead in the blood.[2]

Young children are particularly vulnerable to lead exposure. They tend to put their hands, toys, and other items into their mouths, increasing their chances of eating lead.[4,5] They are also smaller, so the same amount of lead will have more impact in a child than in an adult.[6] The effects of lead on the developing child can be devastating since the central nervous system is undergoing a period of rapid and critical growth.[2,4,6-8] In children, exposure to lead has been linked to:

- Learning and behavioral issues, including ADHD and hyperactivity
- Lower IQ
- Slowed growth and development
- Hearing and speech difficulties
- Anemia

Lead Sources

Lead enters the body through breathing in, eating, or drinking lead. The most common source of lead is from deteriorating lead paint in homes built before the lead paint ban in 1978.[2,6,9-12] Deteriorating paint may be peeling, chipping, blistering, flaking, worn, chalking, cracking, or otherwise becoming separated from the painted surface. This creates hazardous paint chips and dust that can settle on windowsills, floors, porches, and in the soil around the outside of a home. Repair and renovation of these homes can create hazardous lead dust if lead-safe work practices are not followed.[6,10,12]

Since the Flint water crisis, there has been increased concern about lead in drinking water. The focus of this report is on Michigan as a whole; for information about the water crisis, visit the State of Michigan's Flint water response website (Michigan.gov/Flintwater).

[†] MCL 333.5474, http://legislature.mi.gov/doc.aspx?mcl-333-5474

Besides deteriorating paint and leaded plumbing and pipes, there are other visible and invisible sources of lead in and around the home,[4,9-12] including:

- Soil (dirt) on properties near high-traffic streets and highways, from leaded gasoline exhaust
- Soil on former industrial sites like mines or smelters (brownfields)
- Other plumbing fixtures and solder
- Pottery with glazes containing lead
- Hobby supplies, including lead buckshot, fishing weights, and lead cane for stained glass
- Imported cosmetics
- Imported toys, jewelry, or furniture with lead paint or parts
- Imported sauces, spices, candy, health supplements, folk remedies, and ayurvedic medicines[2,4-6,13]

The chances of children being in contact with (exposed to) lead are higher for those living in older homes and in poverty; it is also more common in the children of some ethnic and racial groups.[4,6,13,14] Michigan's urban areas tend to have aging homes, aging plumbing, and substandard living conditions, potentially increasing the risk of lead exposure for those who live in those areas.

Blood Lead Testing and Surveillance (Monitoring)

Exposure to lead is measured by blood tests, where a laboratory determines how much lead is in the blood. This amount is called a blood lead level (BLL). Any blood lead test result above the limit of detection means the person has been exposed to lead.

All blood lead test results must be submitted to the MDHHS CLPPP within five working days after test completion.[‡] CLPPP monitors these results and produces reports for the public.

Targeted Testing

Children under age 6 are the primary focus of testing because they are most likely to experience negative health effects from lead. Children enrolled in Michigan Medicaid programs are required to be tested for lead by age 3.[15] Testing is also required for Michigan children enrolled in the WIC program.[§] For other children under 6 years old, CLPPP provides information to help providers and families determine a child's lead risk, including a lead risk screening questionnaire and other resources.[16,17]

MDHHS recommends blood lead testing for all children determined to be at risk of lead exposure, as indicated by the screening questionnaire.[18] The targeted testing approach and some of the questions used are recommended by the CDC. [19] However, it is unknown how often this tool is actually used by providers and how accurately it identifies children with EBLLs. The most accurate way to determine the true number and proportion of children with elevated lead levels would be to test *all* children in the State of Michigan through a universal testing program.[20]

Elevated Blood Lead Levels

MDHHS and the CDC consider 5 micrograms per deciliter (µg/dL) or more lead in the blood to be an elevated blood lead level (EBLL).[1,2,4-6] This blood lead level initiates a recommendation from MDHHS to the local health department and provider that actions be taken to educate the family to immediately minimize risk of ongoing exposure, identification and removal of lead sources, periodic retests to monitor the child's blood lead level,

[‡] MCL 333.20531 http://legislature.mi.gov/doc.aspx?mcl-333-20531
[§] MCL 400.111l http://legislature.mi.gov/doc.aspx?mcl-400-111l

and provide follow-up medical treatment as needed.[6,17] For more about how this reference value was determined, see the Meaning of an Elevated Result section in the Technical Appendix.

Confirmatory Venous Testing

Blood lead tests are performed on capillary blood samples (from a finger stick) or venous blood samples (from a blood draw). Capillary tests are often used because they are easier to do but they are less reliable than venous tests. Capillary test results are often false positives, meaning the BLL appears to be elevated when it actually is not elevated. For example, 60% of elevated capillary tests were false positives in a recent study.[21] A confirmatory venous blood test should be used to verify elevated levels from capillary blood tests.

Methods

This section includes an overview of the analysis methods used to prepare this report. More detailed information about the analysis is available by topic in the Technical Appendix.

Data Used for Analysis

Blood lead testing and result data in this report are drawn from the CLPPP blood lead surveillance database called MiCLPS (Michigan Childhood Lead Poisoning Surveillance). Demographic and testing variables used for this analysis are listed under Data Elements in the Technical Appendix. Population and risk factor data for children under 6 years old were drawn from the American Community Survey, National Vital Statistics System, and U.S. Census estimates described in Housing Stock and Population Estimates in the Technical Appendix. Medicaid eligible population estimates were downloaded from the December 2018 MDHHS Medicaid Green Book of Key Program Statistics.

Testing Years

The focus of this report is on blood lead test results from 2018; other years are included for comparison. Blood lead test results are available as early as 1998; however, laboratory reporting of test results was inconsistent until 2003. Therefore, only years 2003 through 2018 are included in this report.

Data are current as of March 6, 2020.

Population

Blood lead test results are presented for Michigan children under age 6, as this age group is targeted for testing and is the focus of CLPPP intervention activities. For all tests included in this report, the blood collection date was before the child's 6th birthday.

To report the number of children who were tested in a year (instead of the number of tests overall), it is necessary to deduplicate test results so that only one test is counted for each child. If a child had multiple tests within a calendar year, the highest BLL obtained from the most accurate test, a venous test, was counted. If no venous test was performed, the highest BLL obtained from a capillary test was counted. If the only test results were of unknown sample type, then the highest of these results was counted.

Geographic Areas

The child's residential address is reported by the parent, guardian, physician, or testing laboratory. After CLPPP receives this information, the reported address is corrected for spelling and other errors. Records were excluded from the analysis if they were missing key parts of the address or had a non-Michigan address, based on reported county, city, and ZIP code. See address processing in the technical appendix for more information.

Results in this report are presented for three types of geographies: (1) the state of Michigan, (2) counties, where Detroit is treated as a separate "county" compared to the rest of Wayne County (listed as "Wayne, Detroit" and "Wayne, Ex. Detroit" in the tables), and (3) selected communities. Selected communities are areas with a history of high numbers of children with an EBLL and where MDHHS funds interventions to reduce the risk of lead exposure in children. These communities include the cities of Adrian, Detroit, Flint, Grand Rapids, Hamtramck, Highland Park, Jackson, Lansing, and Muskegon.

Risk Factors for Lead Exposure: Housing and Poverty

Two indicators of older housing are included in the reference tables of this report: the 2018 percentages of housing constructed before 1980 (two years after the lead paint ban), and houses constructed before 1950 (when homes are known to have had high levels of leaded paint).[2,6,8,13,14] See Housing Stock and Population Estimates in the Technical Appendix for more information.

CLPPP defines a child enrolled in Medicaid as a child with at least one blood lead test while they were enrolled in a Medicaid program in the year. Medicaid status is included as a proxy for poverty, which is a risk factor for lead exposure. It is also included because Medicaid requires testing of all Medicaid-enrolled children under age 6.

Analysis

Measures

Blood lead test results were summed to create counts and to calculate proportions (percentages) for groups residing in the different geographic areas. The following measures are included:

- Blood Lead Testing Coverage: Among children under 6 years old, the number and percentage who have had a venous or capillary blood lead test. The percent is the number who have had at least one blood lead test divided by the total number of children under 6 years old in the population (see Housing Stock and Population Estimates in the Technical Appendix for more information) multiplied by 100.
- Elevated Blood Lead Levels: Among children under 6 years old who have had a blood lead test, the number and percentage with an EBLL (≥5 µg/dL). The percent is the number who had an elevated test result divided by the total number of children under 6 who had at least one test multiplied by 100.
- Venous Testing Percentage: Among children under 6 years old who have had an EBLL, the count and percent with a *venous* (confirmed) EBLL. The percent is the number who had at least one venous EBLL test result divided by the number of children under 6 who have had at least one EBLL test from any sample type multiplied by 100.
- High Blood Lead Levels: Among children under 6 years old who have had a blood lead test, the count and percent with a venous BLL at or above 45 µg/dL. The percent is the number who had at least one venous blood lead test result above 45 µg/dL divided by the total number of children who have had at least one test multiplied by 100. At this blood lead level, the child's physician will consult with Michigan's Poison Control Center and consider hospitalization and/or chelation to remove lead from the body.[17]

Reference Tables (Appendix 3): Reference tables include age of housing stock, number of children with at least one test, and number of EBLLs from all samples, capillary samples, and venous samples.

Data Suppression

To protect privacy, counts between one (1) and five (5) are suppressed (not reported); other counts are not reported if they can be used to calculate the suppressed counts. These counts are replaced with an asterisk (*) in the tables. Tables without suppression will be made available to local health departments upon request.

Changes Since Last Report

The CLPPP program is continuously working to improve the quality of reports. Changes in the way CLPPP prepares the data are intended to make these reports more accurate and easier to understand. However, they may result in slightly different data compared to previous annual reports.

- Most of the data in this report and some data that were included in prior annual reports will be posted to the MiTracking website. Data posted on MiTracking is available for public use and will be updated on a quarterly basis. If this data is needed in the format of previous annual reports, it is also available upon request from MDHHS-CLPPP@Michigan.gov.
  Data that will no longer be included in the CLPPP annual report but that is now posted to MiTracking include:
    - Counts of venous BLL categories 5-9 µg/dL, 10-14 µg/dL, 15-19 µg/dL, and 20-44 µg/dL for children < 6 by county and city (previously in the annual report reference tables)
    - Reference tables for children 1-2 years old enrolled in Medicaid (previously in a Medicaid supplemental report)
    - Reference tables for ZIP codes (previously in a ZIP code supplemental report)
- For every new report, CLPPP updates all numbers to reflect any newly reported or updated test results, even if those test results are for past years. This change is made to maintain accuracy. For this reason, there may be slight differences in the numbers presented in this report compared to numbers presented in reports released previously.

Blood Lead Surveillance Results in 2018

Blood Lead Testing Coverage

Michigan Overall

Year-by-Year Comparisons

In 2018, there were 142,387 Michigan children under 6 years old who had a blood lead test, representing 20.8% of the population in that age group (Figure 1, Table 1). Testing rates have increased since 2003, when only 13% (100,356 children) were tested. The testing rate rose to 21% in 2010 and remained steady through 2015. Between 2010 and 2015, the number of tests decreased, but so did the size of Michigan's population in this age group.

There was a notable increase in testing in 2016 associated with the Flint water crisis. Efforts were made to test all city of Flint residents and, with news coverage of the crisis, increased public awareness likely led to more testing in Michigan overall. The year 2016 had the highest number (158,038) and percent (22.9%) of the population under 6 tested for lead in Michigan since the beginning of the CLPPP surveillance program. The testing rate in 2018 (20.8%) has returned to the rate at plateau.

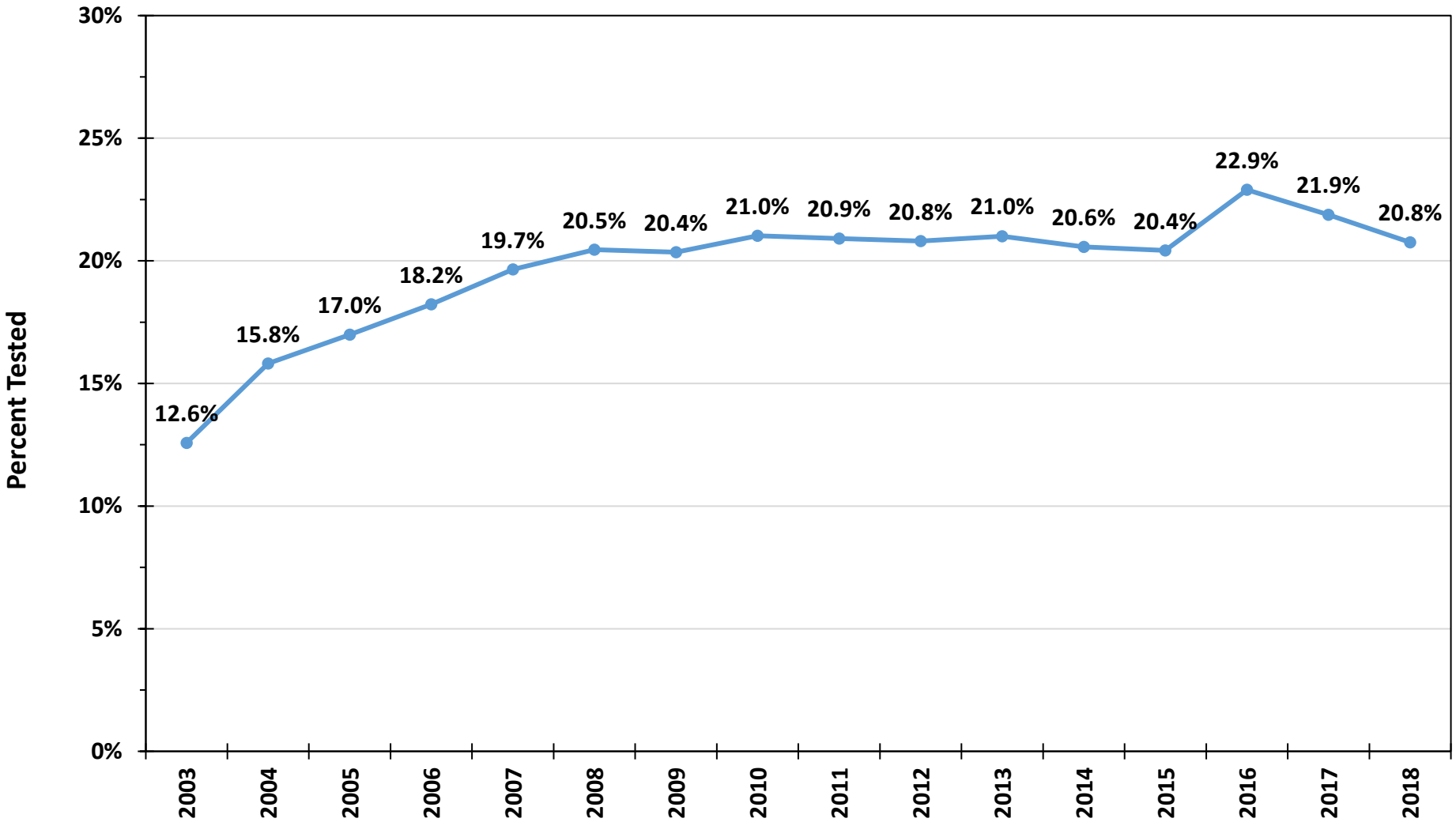
Table 1. Yearly Blood Lead Testing Coverage for Michigan Children Under 6 Years Old, 2003 - 2018

Year	Population*	# Tested	% Tested†	Year	Population*	# Tested	% Tested†
2003	797,847	100,356	12.6	2011	728,409	152,331	20.9
2004	793,480	125,464	15.8	2012	716,637	149,075	20.8
2005	785,850	133,488	17.0	2013	707,903	148,694	21.0
2006	776,156	141,454	18.2	2014	701,063	144,182	20.6
2007	762,649	149,874	19.7	2015	694,168	141,759	20.4
2008	749,205	153,268	20.5	2016	690,245	158,038	22.9
2009	759,362	154,567	20.4	2017	687,562	150,456	21.9
2010	741,970	156,006	21.0	2018	685,986	142,387	20.8

* 2009 - 2018: American Community Survey 5-year population estimates, Table B09001
2003 - 2008: 2010 CDC NVSS bridged-race population estimates

† Percent is among the population (% Tested = (# Tested / Population) x 100)

Figure 1. Annual Percent of Michigan Children Under 6 Years Old Tested for Blood Lead, 2003 – 2018



Population data from:
2009 - 2018: American Community Survey 5-year population estimates, Table B09001
2003 - 2008: 2010 CDC NVSS bridged-race population estimates
Blood lead testing data from MDHHS, as of March 6, 2020

Comparisons by Child Characteristics

- Over one-half (52.2%) of 1 year olds in Michigan were tested for lead in 2018 (Table 2). Just over a quarter (26.9%) of 2 year olds were tested for lead and all other ages were tested less.
- The testing rate for children enrolled in Medicaid was nearly twice the rate in non-Medicaid children (27.6% vs 14.0%, respectively). Over half of children enrolled in Medicaid who were 1 to 2 years old were tested for blood lead. This makes sense, due to the requirement that children enrolled in Medicaid be tested before their third birthday.[16]
- Testing coverage was nearly the same for males and females (20.1% and 20.3%, respectively).

Table 2. Blood Lead Testing Coverage for Michigan Children Under 6 Years Old by Characteristic, 2018

Characteristic	Population	# Tested	% Tested ‡
Age < 1	110,301*	16,098	14.6
Age 1	113,010*	58,976	52.2
Age 2	115,262*	30,977	26.9
Age 3	116,558*	14,230	12.2
Age 4	117,032*	15,548	13.3
Age 5	116,164*	6,558	5.6
Medicaid	339,026**	93,509	27.6
Non-Medicaid	349,301ǂ	48,878	14.0
Medicaid Age 1-2	110,302**	56,897	51.6
Female	336,492*	68,376	20.3
Male	351,835*	70,873	20.1
Sex Not Reported	Not Applicable	3,138	Not Applicable
Total	**688,327**	**142,387**	**20.7**

* 2018 US Census population estimates, table PEPSYASEX. Note that population estimates for children under 6 years old may be different in other tables, where different population estimates are used.

** December 2018 Medicaid Green Book estimate of Medicaid eligible population, Table 70

ǂ Michigan population estimate minus the Medicaid eligible population estimate

‡ Percent is among the population (% Tested = (# Tested / Population) x 100)

Michigan Counties

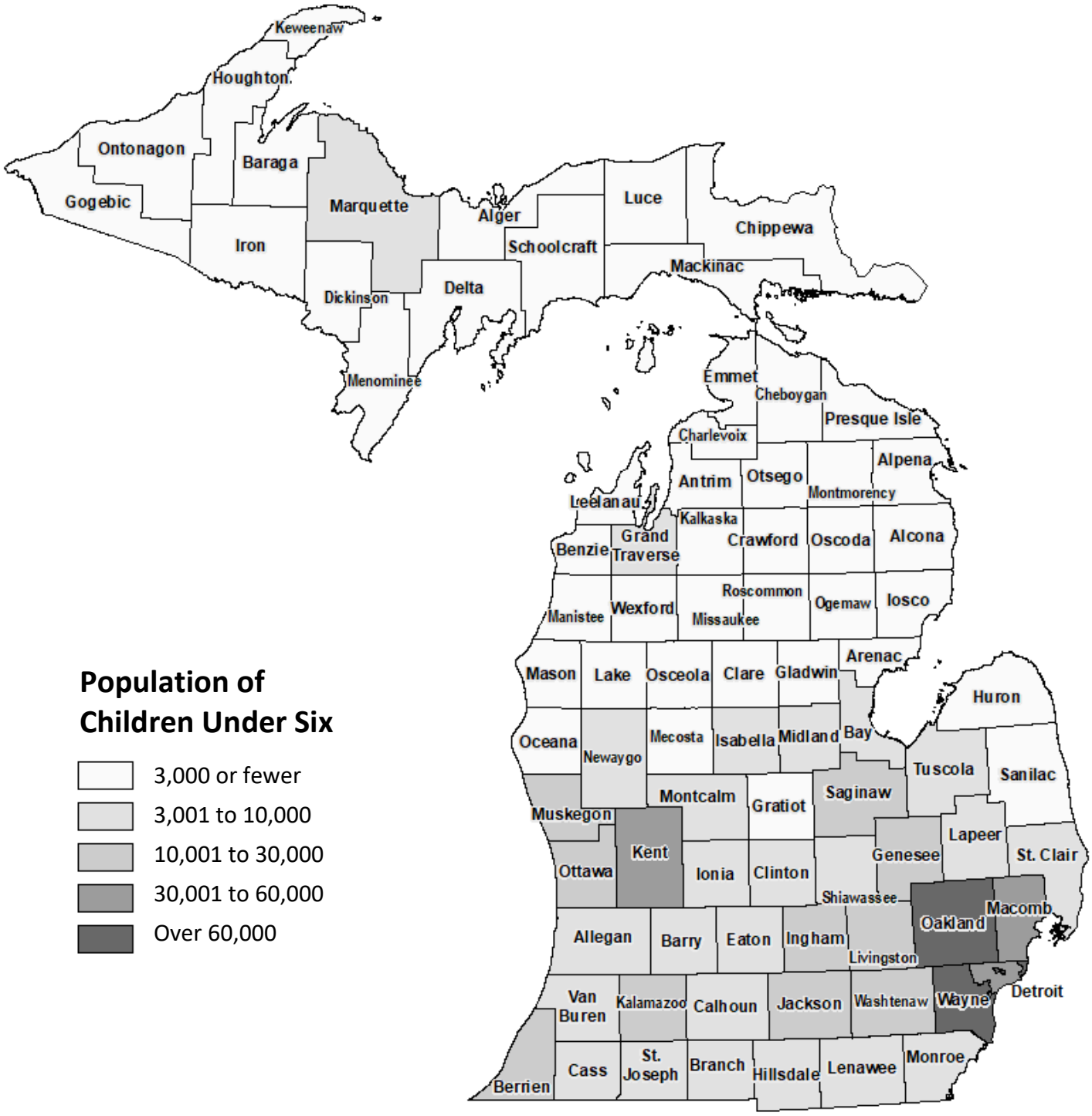
Counties with the highest populations of the children under 6 years old were also the areas where the highest numbers were tested (Figure 2, Figure 3, Table 3). The counties with the highest testing rates (Figure 4, Table 3) were:

- Among counties with a population over 10,000: Wayne, Detroit (34.0%, 19,973 children), Jackson (26.6%, 2,907 children), Saginaw (23.9%, 3,139 children), Ingham (23.3%, 4,608 children), and Wayne without Detroit (23.2%, 18,263 children).
- Among counties with populations less than 10,000: Shiawassee (29.6%, 1,225 children), Saint Clair (27.8%, 2,691 children), and Baraga (26.9%, 126 children).

Like the state, most (60 out of 84) counties saw a decrease in testing rates since 2017. Of the 22 counties that saw improvement, those with most improvement since 2017 included Iron (+4.6%), Keweenaw (+4.3%), and Alcona (3.8%) counties.**

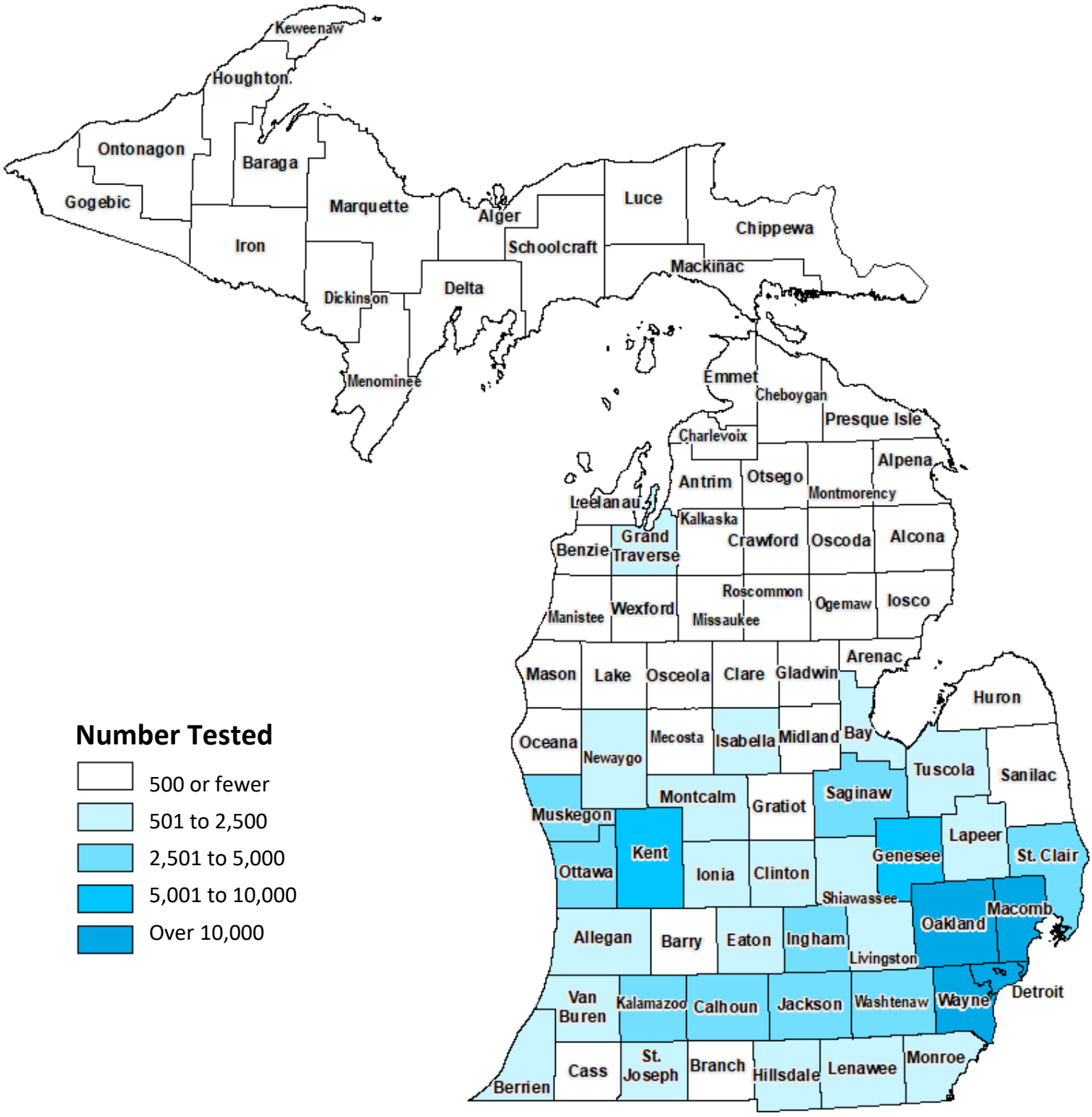
** See the MiTracking data portal (https://mitracking.state.mi.us/) for the most up-to-date data from 2017.

Figure 2. Population of Michigan Children Under 6 Years Old by County of Residence, 2018



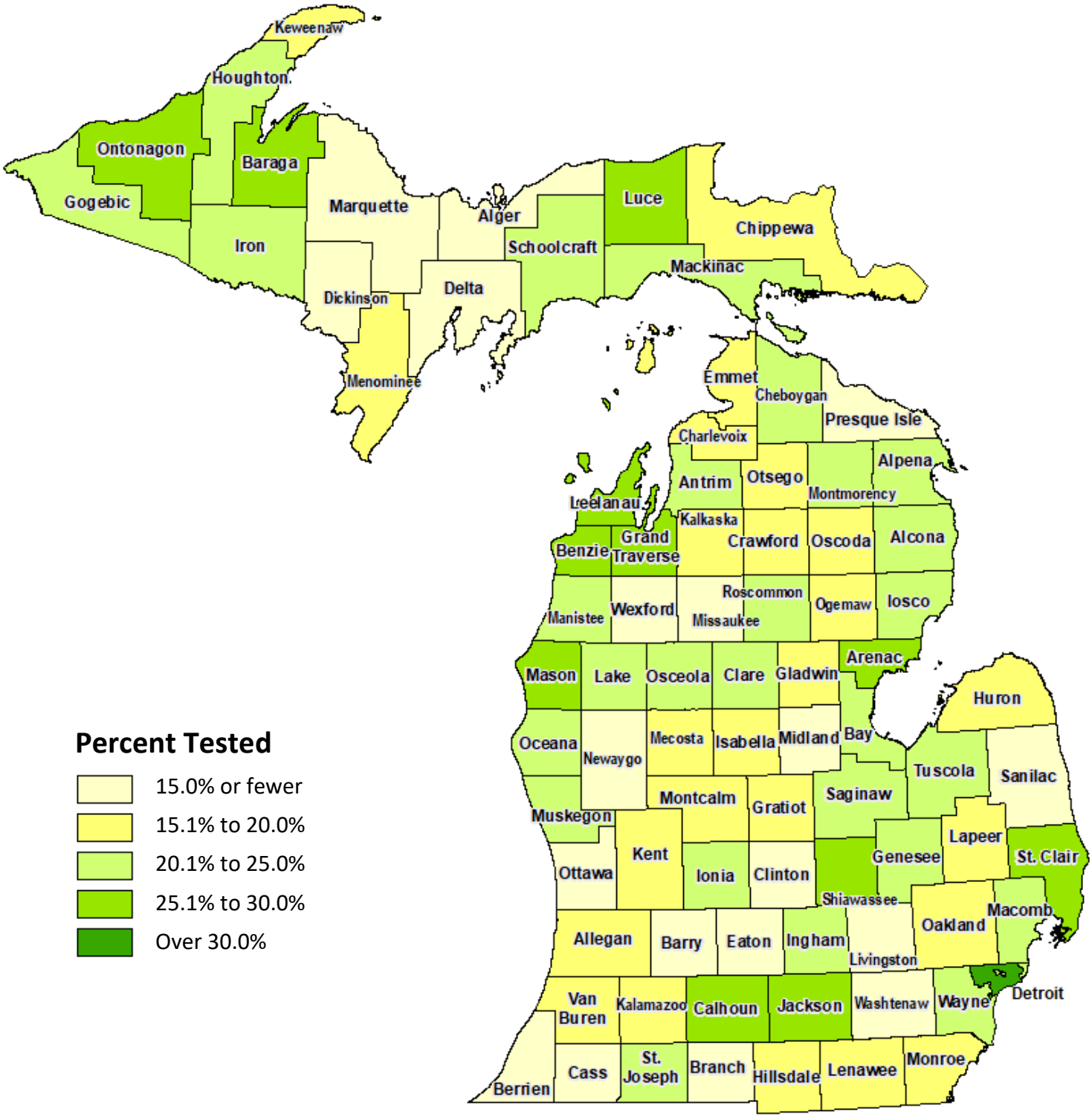
Population data from 2018 American Community Survey 5-Year Population Estimates, Table B09001

Figure 3. Number of Michigan Children Under 6 Years Old Tested for Blood Lead by County of Residence, 2018



Michigan blood lead testing data from MDHHS, as of March 6, 2020

Figure 4. Percent of Michigan Children Under 6 Years Old Tested for Blood Lead by County of Residence, 2018



Population data from 2018 American Community Survey 5-Year Population Estimates, Table B09001

Michigan blood lead testing data from MDHHS, as of March 6, 2020

Table 3: County Blood Lead Testing Coverage for Michigan Children Under 6 Years Old, 2018

County	Population*	# Tested	% Tested[ǂ]	County	Population*	# Tested	% Tested[ǂ]
MICHIGAN	**685,986**	**142,387**	**20.8**	LAKE	572	136	23.8
ALCONA	384	95	24.7	LAPEER	5,302	932	17.6
ALGER	439	61	13.9	LEELANAU	1,062	272	25.6
ALLEGAN	8,537	1,322	15.5	LENAWEE	6,231	1,148	18.4
ALPENA	1,567	320	20.4	LIVINGSTON	11,692	1,075	9.2
ANTRIM	1,220	277	22.7	LUCE	306	79	25.8
ARENAC	816	211	25.9	MACKINAC	496	119	24.0
BARAGA	468	126	26.9	MACOMB	57,406	12,177	21.2
BARRY	3,954	386	9.8	MANISTEE	1,158	275	23.7
BAY	6,200	1,296	20.9	MARQUETTE	3,922	456	11.6
BENZIE	959	253	26.4	MASON	1,788	452	25.3
BERRIEN	10,844	1,565	14.4	MECOSTA	2,496	391	15.7
BRANCH	3,286	373	11.4	MENOMINEE	1,314	230	17.5
CALHOUN	9,739	2,608	26.8	MIDLAND	5,561	404	7.3
CASS	3,042	363	11.9	MISSAUKEE	1,132	132	11.7
CHARLEVOIX	1,421	236	16.6	MONROE	9,631	1,468	15.2
CHEBOYGAN	1,228	247	20.1	MONTCALM	4,288	796	18.6
CHIPPEWA	2,229	409	18.3	MONTMORENCY	394	80	20.3
CLARE	2,020	410	20.3	MUSKEGON	12,718	2,660	20.9
CLINTON	5,149	680	13.2	NEWAYGO	3,440	510	14.8
CRAWFORD	705	113	16.0	OAKLAND	82,634	16,312	19.7
DELTA	2,199	318	14.5	OCEANA	1,880	467	24.8
DICKINSON	1,546	221	14.3	OGEMAW	1,159	215	18.6
EATON	7,479	1,099	14.7	ONTONAGON	162	42	25.9
EMMET	1,834	305	16.6	OSCEOLA	1,472	338	23.0
GENESEE	29,030	6,362	21.9	OSCODA	481	80	16.6
GLADWIN	1,572	297	18.9	OTSEGO	1,560	250	16.0
GOGEBIC	681	162	23.8	OTTAWA	21,745	3,092	14.2
GRAND TRAVERSE	5,690	1,463	25.7	PRESQUE ISLE	549	76	13.8
GRATIOT	2,433	412	16.9	ROSCOMMON	1,020	210	20.6
HILLSDALE	3,173	564	17.8	SAGINAW	13,122	3,139	23.9
HOUGHTON	2,346	500	21.3	SAINT CLAIR	9,668	2,691	27.8
HURON	1,908	369	19.3	SAINT JOSEPH	4,776	988	20.7
INGHAM	19,749	4,608	23.3	SANILAC	2,648	355	13.4
IONIA	4,434	968	21.8	SCHOOLCRAFT	417	89	21.3
IOSCO	1,323	286	21.6	SHIAWASSEE	4,145	1,225	29.6
IRON	554	122	22.0	TUSCOLA	3,340	730	21.9
ISABELLA	3,971	690	17.4	VAN BUREN	5,452	910	16.7
JACKSON	10,937	2,907	26.6	WASHTENAW	21,405	2,931	13.7
KALAMAZOO	18,784	3,194	17.0	WAYNE, DETROIT	58,795	19,973	34.0
KALKASKA	1,080	202	18.7	WAYNE, NO DETROIT	78,870	18,263	23.2
KENT	52,387	9,490	18.1	WEXFORD	2,346	307	13.1
KEWEENAW	114	22	19.3	**MICHIGAN**	**685,986**	**142,387**	**20.8**

* Population data from 2018 American Community Survey 5-year population estimates, table B09001 (numbers of children living in households)

[ǂ] Percent is among population of children under 6 years old (% Tested = (# Children < 6 Tested / Population Children < 6) × 100)

Selected Communities

The testing rate for children under 6 years old was higher in all nine selected communities compared to Michigan overall (Table 4). The highest rates were in Jackson (75.2%, 2,249 children), Hamtramck (49.0%, 1,210 children), and Muskegon (46.9%, 2,109 children).

Table 4: Selected Community Blood Lead Testing Coverage for Michigan Children Under 6 Years Old, 2018

Community	Population*	# Tested	% Tested[ǂ]
ADRIAN	1,442	556	38.6
DETROIT	58,795	19,973	34.0
FLINT	8,543	3,340	39.1
GRAND RAPIDS	17,250	6,053	35.1
HAMTRAMCK	2,467	1,210	49.0
HIGHLAND PARK	915	310	33.9
JACKSON	2,989	2,249	75.2
LANSING	9,910	3,686	37.2
MUSKEGON	4,301	2,019	46.9
MICHIGAN	**685,986**	**142,387**	**20.8**

* Population data from 2018 American Community Survey 5-year population estimates, table B09001 (numbers of children living in households)

[ǂ] Percent is among population of children under 6 years old (% Tested = (# Children < 6 Tested / Population Children < 6) × 100)

Elevated Blood Lead Levels

Michigan Overall

Year-by-Year Comparisons

The prevalence of EBLLs among children tested has declined over the years (Table 5, Figure 5), from 20% in 2003 to 2.9% in 2018 (a 17.1% reduction). Over the last five years, however, there has been little change in the prevalence (3.9% to 2.9%). While some of the decrease is likely due to the success of programs to reduce lead exposure, there are many other factors that may have contributed to this decline, making year-to-year comparisons difficult to interpret:

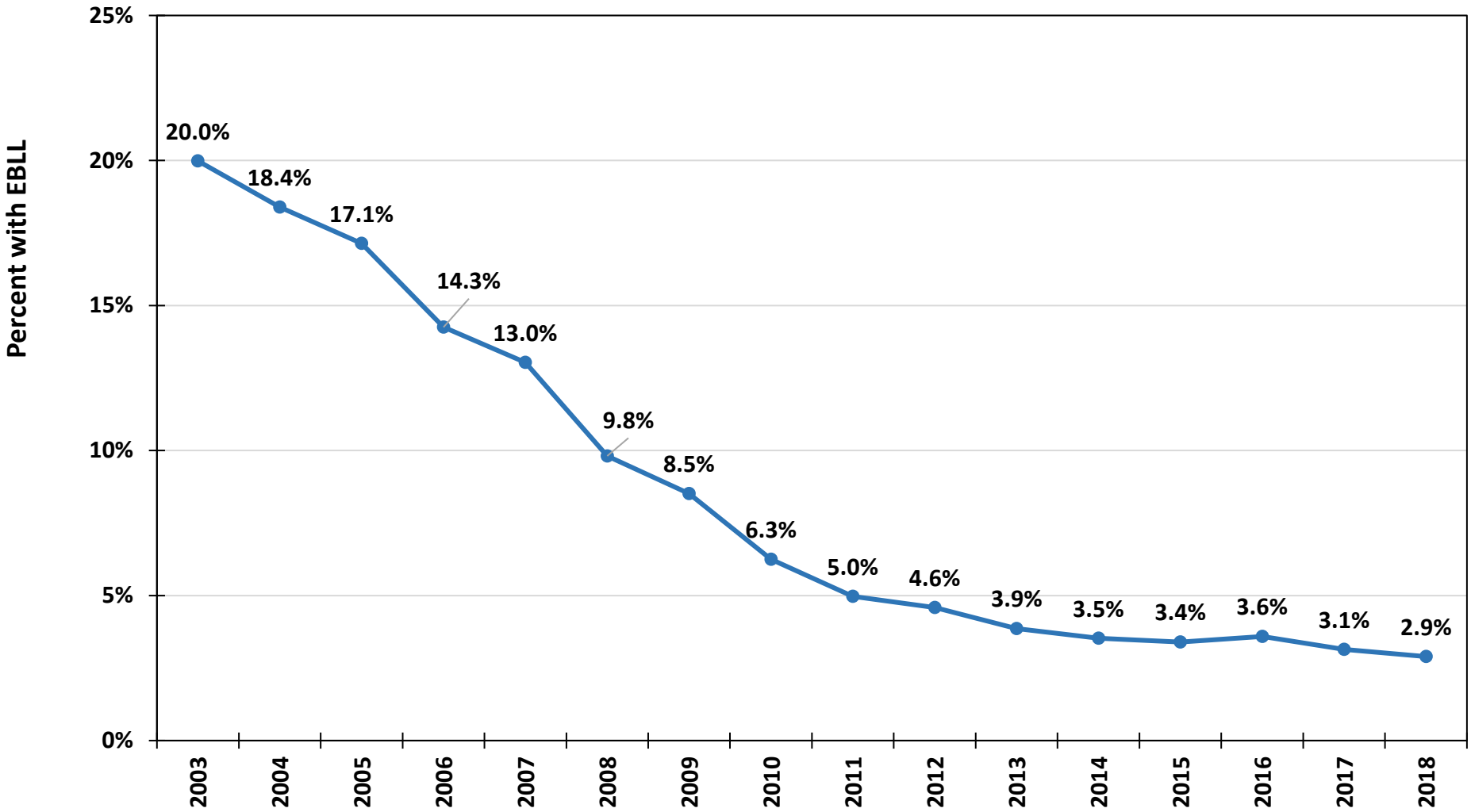
- There have been changes in blood lead testing rules and practices (see blood lead testing history in the Technical Appendix). Most notably, the testing rate among all children under age 6 rose after Michigan passed additional requirements for Medicaid testing in 2004; the rate increased from 12% in 2003 to 19% in 2007 (Figure 1). The rate then plateaued, staying around 20-21% until 2016, when there was increased blood lead testing across the entire state. These changes mean that the population tested in one year is likely different from another; accordingly, the children tested may have different underlying risks for lead exposure, which could impact the numbers and percentages of children with elevated blood lead levels.
- There have been changes in confirmatory testing practices (see confirmatory venous testing in the Technical Appendix), which may affect venous confirmatory testing rates. In fact, the proportion of EBLLs from venous tests has increased since 2014 (Table 10). Because capillary tests tend to overestimate blood lead levels, the EBLL percent will likely be lower if there is a higher proportion of tests that are venous tests.

Table 5. Annual Elevated Blood Lead Levels (EBLLs, ≥5 µg/dL) Among Tested Michigan Children Under 6 Years Old, 2003-2018

Year	# Tested	# EBLL	% EBLL[†]	Year	# Tested	# EBLL	% EBLL[†]
2003	100,356	20,057	20.0	2011	152,331	7,571	5.0
2004	125,464	23,075	18.4	2012	149,075	6,833	4.6
2005	133,488	22,880	17.1	2013	148,694	5,746	3.9
2006	141,454	20,160	14.3	2014	144,182	5,089	3.5
2007	149,874	19,545	13.0	2015	141,759	4,820	3.4
2008	153,268	15,039	9.8	2016	158,038	5,669	3.6
2009	154,567	13,155	8.5	2017	150,456	4,725	3.1
2010	156,006	9,753	6.3	2018	142,387	4,124	2.9

[†] Percent is among those tested (% EBLL = (# EBLL / # Tested) × 100)

Figure 5. Annual Percent of Elevated Blood Lead Levels (EBLLs, ≥5 µg/dL) Among Tested Michigan Children Under 6 Years Old, 2003 -2018



Blood lead testing data from MDHHS, as of March 6, 2020

Comparisons by Child Characteristics

- Children who were 3 years old had the highest percentage with an EBLL (4.2%, see Table 6). Some of this difference may be explained by lower testing rates (12.2%, see Table 2) in this age group (see targeted testing).
- The EBLL percent was twice as high (3.5%) in Medicaid children compared to non-Medicaid children (1.7%). This is likely a true difference because (1) the rate of testing among Medicaid children was higher than for non-Medicaid children (27.6% and 14.0%, respectively; see Table 2) and (2) those enrolled in Medicaid are more likely to be exposed to lead.[18]
- The EBLL percent was not substantially different between males (3.1%) and females (2.8%).

Table 6. Elevated Blood Lead Levels (EBLLs, ≥5 µg/dL) Among Tested Michigan Children Under 6 Years Old by Characteristic, 2018

Characteristic	# Tested	# EBLL	% EBLL[ǂ]
Age < 1	16,098	266	1.7
Age 1	58,976	1,510	2.6
Age 2	30,977	1,045	3.4
Age 3	14,230	596	4.2
Age 4	15,548	484	3.1
Age 5	6,558	223	3.4
Medicaid	93,509	3,314	3.5
Non-Medicaid	48,878	810	1.7
Medicaid Age 1-2	56,897	2,040	3.6
Female	68,376	1,896	2.8
Male	70,873	2,164	3.1
Sex Not Reported	3,138	64	2.0
Total	**142,387**	**4,124**	**2.9**

[ǂ] Percent is among those tested (% EBLL = (# EBLL / # Tested) × 100)

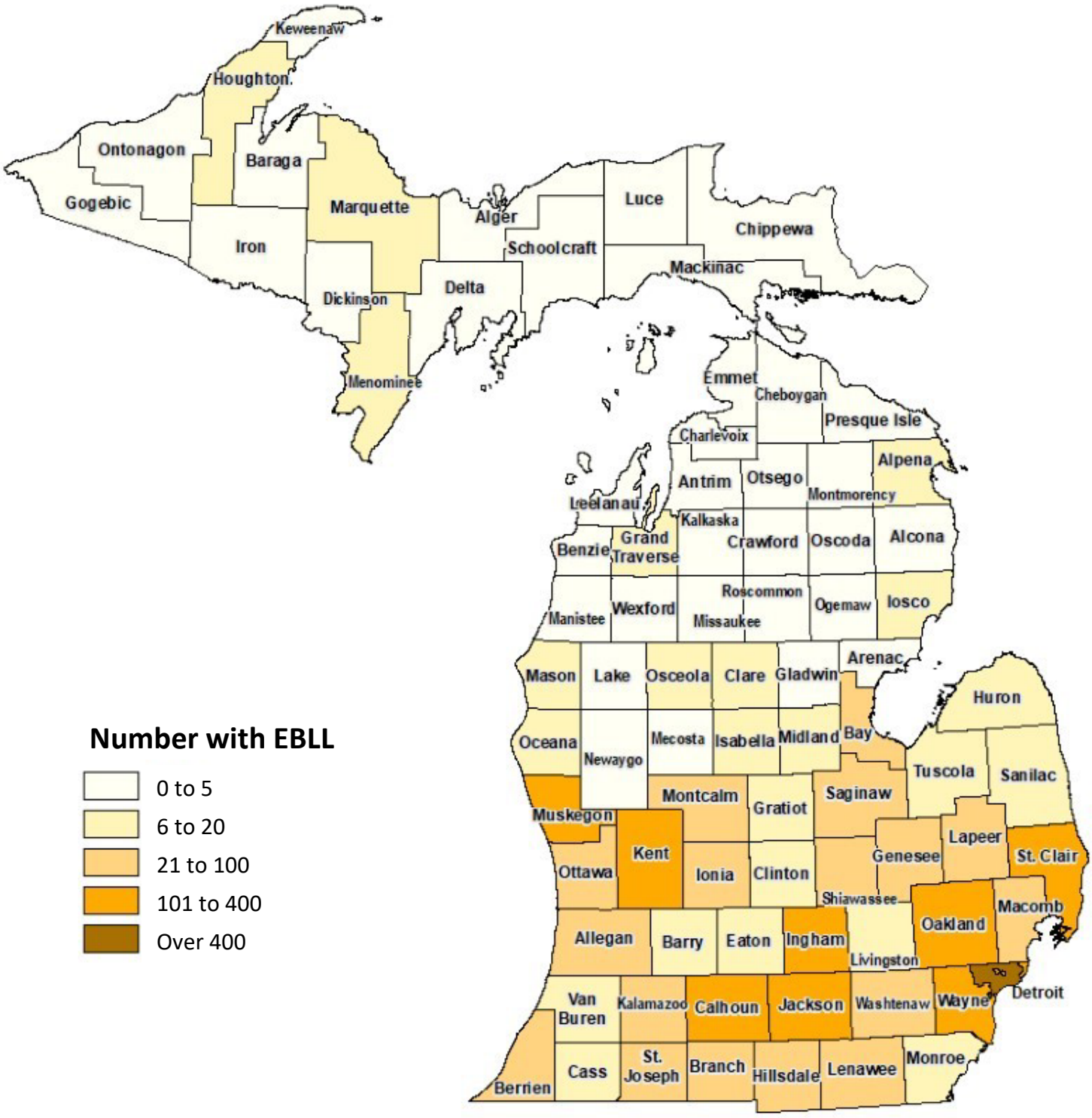
Michigan Counties

Thirty-six counties (64%) had an EBLL percentage less than the state overall (2.9%), including 16 counties below 1.5% EBLL. Twenty-one counties had a higher EBLL percentage than the state and the remaining 27 counties had numbers of EBLLs requiring suppression (Table 5, Figure 7, Table 7). Among counties with at least six children with EBLLs:

- Those with the highest numbers of children with an EBLL were the city of Detroit (1,407 children), Kent (330 children), and Wayne County excluding Detroit (311 children).
- Those with the highest percent of children under 6 with an EBLL among all tested were the city of Detroit (7.0%, 1,407 children), Branch (6.7%, 25 children), Muskegon (5.8%, 154 children), and Calhoun (5.8%, 150 children).
- Twenty-three counties had a lower EBLL percentage in 2018 than in 2017. Counties with the most improvement included Monroe (down 1.4%), Claire, Iosco, and Cass (all down 1.1%).[††]

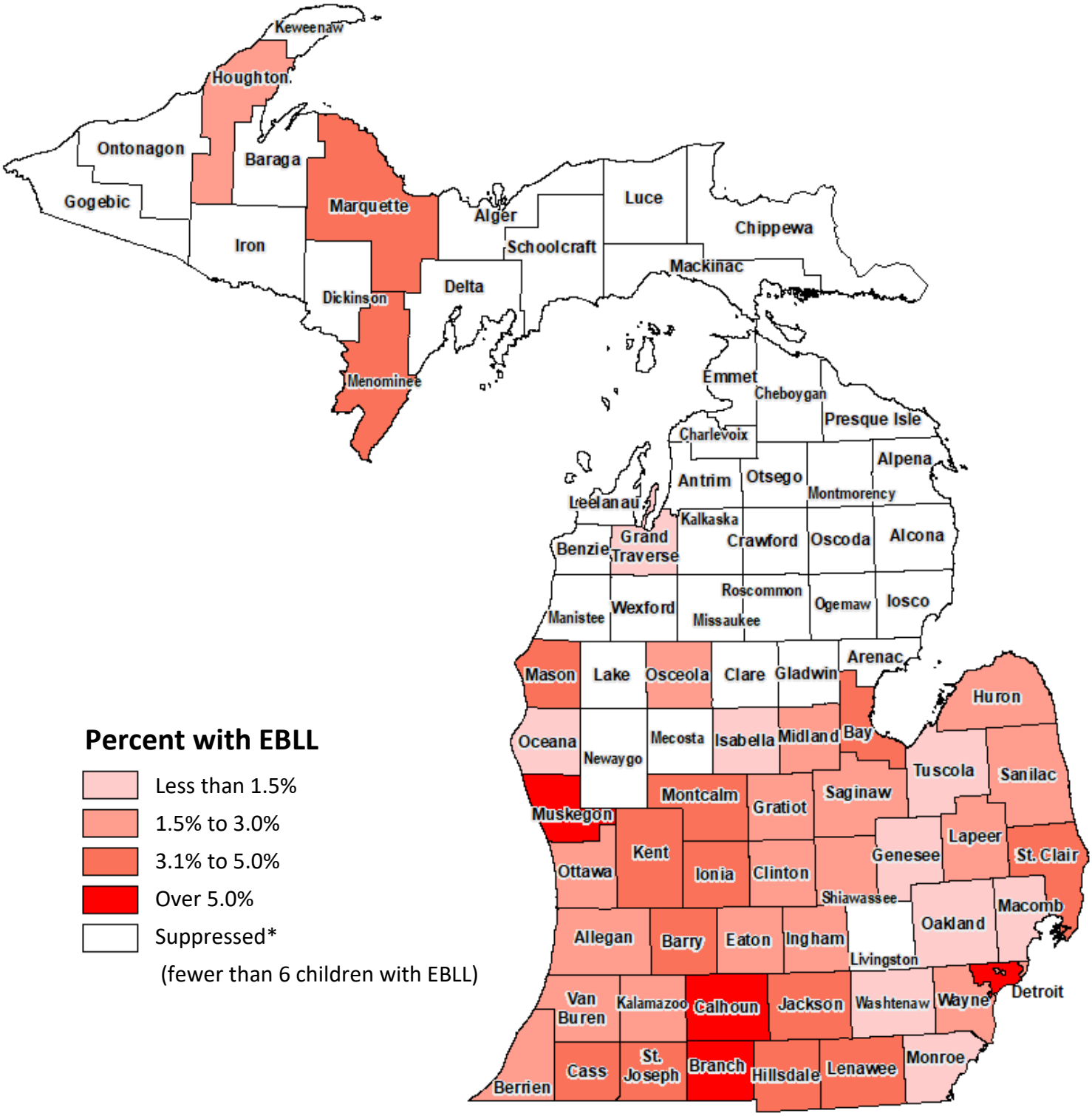
[††] See the MiTracking data portal (https://mitracking.state.mi.us/) for the most up-to-date data from 2018.

Figure 6. Number of Tested Michigan Children Under 6 Years Old with Elevated Blood Lead Levels (≥5 µg/dL, EBLL) by County of Residence, 2018



Michigan blood lead testing data from MDHHS, as of March 6, 2020

Figure 7. Percent of Tested Michigan Children Under 6 Years Old with Elevated Blood Lead Levels (≥5 µg/dL, EBLL) by County of Residence, 2018



Michigan blood lead testing data from MDHHS, as of March 6, 2020

*Percentages based on counts between one (1) and five (5) are suppressed in order to protect the privacy of people who had a blood lead test.

Table 7: County Elevated Blood Lead Levels (EBLLs, ≥5 µg/dL) Among Tested Children Under 6 Years Old, 2018

County	# Tested[ǂ]	# EBLL	% EBLL[ǂ]	County	# Tested	# EBLL	% EBLL[ǂ]
MICHIGAN	**142,387**	**4,124**	**2.9**	LAKE	136	*	-
ALCONA	95	*	-	LAPEER	932	21	2.3
ALGER	61	*	-	LEELANAU	272	0	0.0
ALLEGAN	1,322	26	2.0	LENAWEE	1,148	41	3.6
ALPENA	320	6	1.9	LIVINGSTON	1,075	6	0.6
ANTRIM	277	*	-	LUCE	79	*	-
ARENAC	211	*	-	MACKINAC	119	*	-
BARAGA	126	*	-	MACOMB	12,177	88	0.7
BARRY	386	19	4.9	MANISTEE	275	*	-
BAY	1,296	47	3.6	MARQUETTE	456	16	3.5
BENZIE	253	*	-	MASON	452	20	4.4
BERRIEN	1,565	39	2.5	MECOSTA	391	*	-
BRANCH	373	25	6.7	MENOMINEE	230	8	3.5
CALHOUN	2,608	150	5.8	MIDLAND	404	7	1.7
CASS	363	17	4.7	MISSAUKEE	132	*	-
CHARLEVOIX	236	0	0.0	MONROE	1,468	18	1.2
CHEBOYGAN	247	0	0.0	MONTCALM	796	29	3.6
CHIPPEWA	409	*	-	MONTMORENCY	80	0	0.0
CLARE	410	6	1.5	MUSKEGON	2,660	154	5.8
CLINTON	680	17	2.5	NEWAYGO	510	*	-
CRAWFORD	113	0	0.0	OAKLAND	16,312	214	1.3
DELTA	318	*	-	OCEANA	467	7	1.5
DICKINSON	221	*	-	OGEMAW	215	*	-
EATON	1,099	19	1.7	ONTONAGON	42	*	-
EMMET	305			OSCEOLA	338	7	2.1
GENESEE	6,362	94	1.5	OSCODA	80	0	0.0
GLADWIN	297	*	-	OTSEGO	250	*	-
GOGEBIC	162	*	-	OTTAWA	3,092	61	2.0
GRAND TRAVERSE	1,463	16	1.1	PRESQUE ISLE	76	*	-
GRATIOT	412	9	2.2	ROSCOMMON	210	*	-
HILLSDALE	564	22	3.9	SAGINAW	3,139	95	3.0
HOUGHTON	500	9	1.8	SAINT CLAIR	2,691	106	3.9
HURON	369	7	1.9	SAINT JOSEPH	988	42	4.3
INGHAM	4,608	138	3.0	SANILAC	355	8	2.3
IONIA	968	46	4.8	SCHOOLCRAFT	89	*	-
IOSCO	286	6	2.1	SHIAWASSEE	1,225	37	3.0
IRON	122	*	-	TUSCOLA	730	9	1.2
ISABELLA	690	7	1.0	VAN BUREN	910	20	2.2
JACKSON	2,907	141	4.9	WASHTENAW	2,931	37	1.3
KALAMAZOO	3,194	84	2.6	WAYNE, DETROIT	19,973	1,407	7.0
KALKASKA	202	0	0.0	WAYNE, NO DETROIT	18,263	311	1.7
KENT	9,490	330	3.5	WEXFORD	307	*	-
KEWEENAW	22	0	0.0	**MICHIGAN**	**142,387**	**4,124**	**2.9**

* Counts between one (1) and five (5) are suppressed (not reported) and replaced with an asterisk (*) in the table above to protect the privacy. Other counts are not reported if they can be used to calculate the suppressed counts.

[ǂ] Percent is among those tested (% EBLL = (# EBLL / # Tested) × 100)

Selected Communities

Eight of the nine selected communities had higher EBLL percentages than the state (2.9%) in 2018 (Table 8).

- The highest numbers of children with an EBLL were in Detroit (1,407 children), Grand Rapids (277 children), and Muskegon (145 children).
- The highest EBLL percentages of tested children were in Highland Park (14.8%, 46 children), Muskegon (7.2%, 145 children), and Detroit (7.0%, 1,407 children).

Similar to the state overall, EBLL percentages have decreased since 2015 in the majority of selected communities (Figure 8, Table 9). However, comparisons between years in these selected communities are subject to the same limitations listed for statewide year-to-year comparisons (see Limitations of Year-to-Year Comparisons). Between 2017 and 2018, for children under 6 years old:

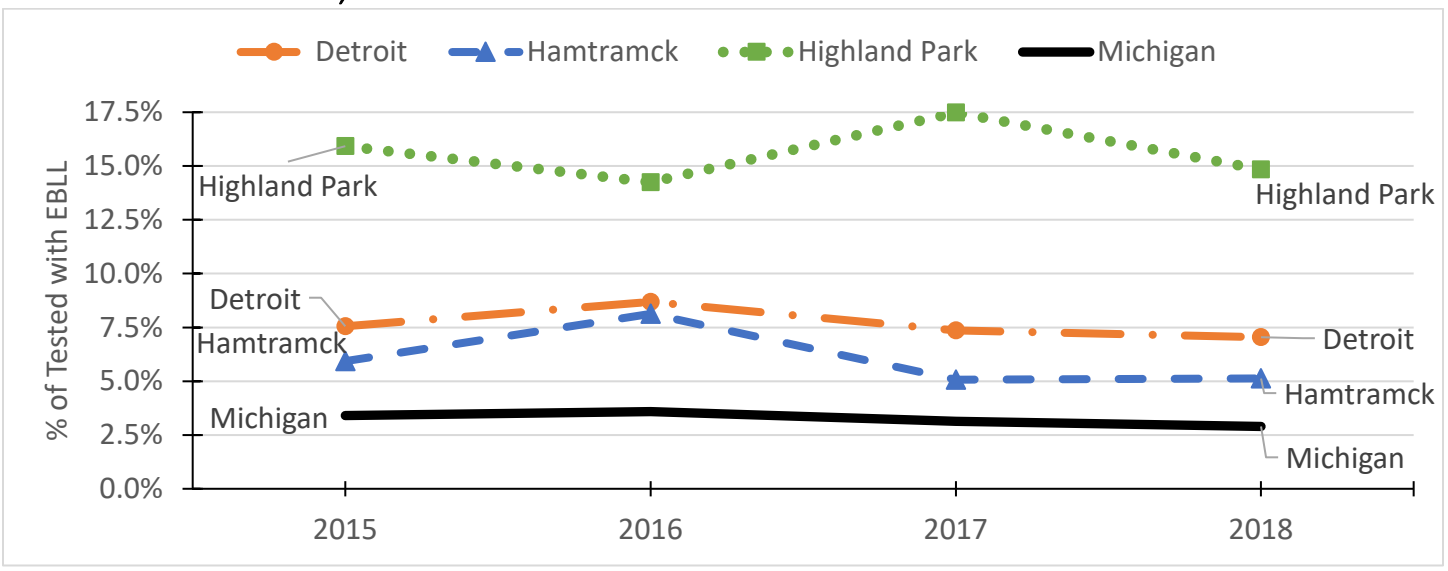
- The percent with an EBLL increased only in Muskegon (up 0.6%) and stayed the same in Hamtramck.
- The percent with an EBLL decreased the most in Highland Park (down 2.7%), Jackson (down 1.7%), Adrian (down 1.1%), and Grand Rapids (down 1.1%).
- Lesser decreases in EBLL proportion were seen in Detroit (down 0.4%), Flint (down 0.4%), and Lansing (down 0.6%).

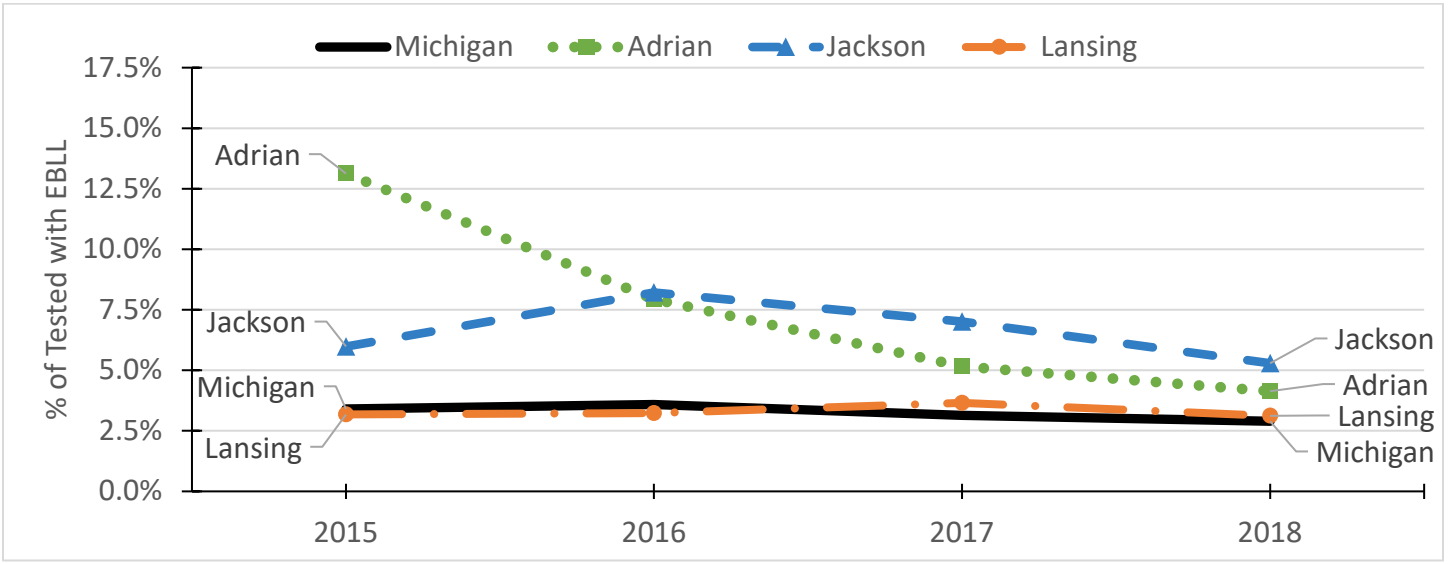
Table 8. Selected Community Elevated Blood Lead Levels (EBLLs, ≥5 µg/dL) Among Tested Michigan Children Under 6 Years Old, 2018

Community	# Tested	# EBLL	% EBLL[ǂ]
ADRIAN	556	23	4.1
DETROIT	19,973	1,407	7.0
FLINT	3,340	78	2.3
GRAND RAPIDS	6,053	277	4.6
HAMTRAMCK	1,210	62	5.1
HIGHLAND PARK	310	46	14.8
JACKSON	2,249	119	5.3
LANSING	3,686	115	3.1
MUSKEGON	2,019	145	7.2
MICHIGAN	**142,387**	**4,124**	**2.9**

[ǂ] Percent is among those tested (% EBLL = (# EBLL / # Tested) × 100).

Figure 8. Percent of Children Under 6 Years Old with Elevated Blood Lead Levels (≥ 5 µg/dL) in Selected Communities, 2015-2018





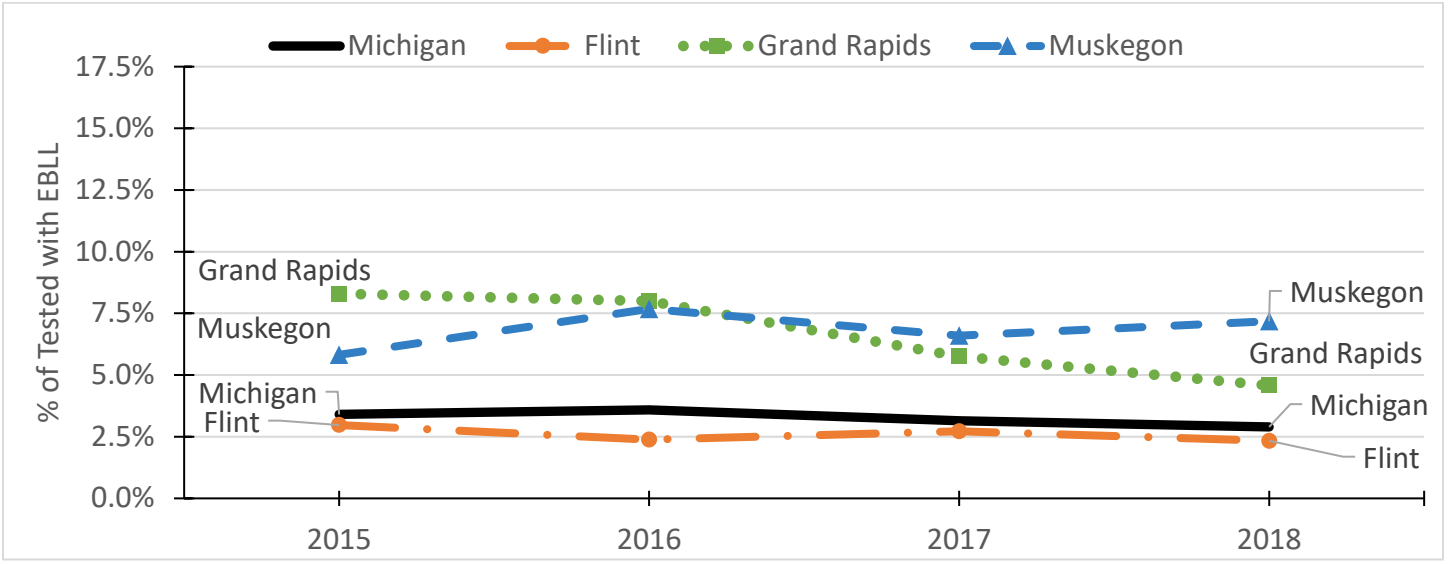


Table 9. Blood Lead Levels for Children Under 6 Years Old in Selected Communities, 2015-2018

Community	# Tested 2015	# EBLL 2015	% EBLL[ǂ] 2015	# Tested 2016	# EBLL 2016	% EBLL[ǂ] 2016	# Tested 2017	# EBLL 2017	% EBLL[ǂ] 2017	# Tested 2018	# EBLL 2018	% EBLL[ǂ] 2018
ADRIAN	518	68	13.1	554	44	7.9	601	31	5.2	556	23	4.1
DETROIT	21,624	1,633	7.6	23,682	2,057	8.7	22,345	1,643	7.4	19,973	1,407	7.0
FLINT	3,803	113	3.0	7,393	176	2.4	3,487	95	2.7	3,340	78	2.3
GRAND RAPIDS	6,304	523	8.3	6,638	531	8.0	6,455	371	5.7	6,053	277	4.6
HAMTRAMCK	961	57	5.9	1,181	96	8.1	1,144	58	5.1	1,210	62	5.1
HIGHLAND PARK	314	50	15.9	337	48	14.2	326	57	17.5	310	46	14.8
JACKSON	2,288	137	6.0	2,216	182	8.2	1,997	140	7.0	2,249	119	5.3
LANSING	3,687	117	3.2	3,738	121	3.2	3,694	135	3.7	3,686	115	3.1
MUSKEGON	1,873	109	5.8	1,810	139	7.7	1,849	122	6.6	2,019	145	7.2
MICHIGAN	**141,759**	**4,820**	**3.4**	**158,038**	**5,669**	**3.6**	**150,456**	**4,725**	**3.1**	**142,387**	**4,124**	**2.9**

[ǂ] Percent is among all tested children under 6 years old (% Tested = (# EBLL / # All Children Tested) × 100).

Venous Testing Proportion

Michigan Overall

Capillary tests are useful for screening, but they are less accurate than venous tests. This is why the CDC and MDHHS CLPPP recommend that any elevated capillary blood lead test be followed by a venous blood test to confirm that a child truly has an EBLL.[2,18] Historically, both of these blood lead tests were done in clinical laboratories.

The proportion of EBLLs from venous tests decreased from 2003 (66.4%) through 2013 (47.8%) (Table 10). In 2006, the Food and Drug Administration (FDA) approved point-of-care lead testing, using machines like the LeadCare™ analyzer. This allowed capillary blood lead tests to be done in any clinic,[14] where a blood draw for a confirmatory venous test may not be readily available. Expanded capillary point-of-care testing *without* appropriate venous confirmatory testing may have contributed to the decrease in the proportion of venous EBLL since 2006.

The BLL considered to be 'elevated' changed from 10 µg/dL to 5 µg/dL in 2012, so confirmatory venous testing was recommended at lower blood lead levels than before. The proportion of venous EBLLs did not change in the year following this new recommendation but did increase substantially in 2014 (from 47.8% to 53.4%). Additionally, CLPPP has been working with local health departments and healthcare providers for the last several years to increase venous confirmatory testing. Recent efforts appear to have been successful, with the proportion of venous EBLL at 58.3% in 2018 - its highest level since 2006.

Table 10. Number and Percentage of EBLLs based on Venous Blood Lead Tests for Michigan Children Under 6 Years Old by Year, 2003–2018

Year	# All EBLL	# Venous EBLL	% Venous EBLL[ŧ]	Year	# All EBLL	# Venous EBLL	% Venous EBLL[ŧ]
2003	20,057	13,323	66.4	2011	7,571	4,007	52.9
2004	23,075	14,603	63.3	2012	6,833	3,311	48.5
2005	22,880	14,120	61.7	2013	5,746	2,744	47.8
2006	20,160	11,536	57.2	2014	5,089	2,719	53.4
2007	19,545	10,586	54.2	2015	4,820	2,508	52.0
2008	15,039	8,206	54.6	2016	5,669	2,916	51.4
2009	13,155	6,577	50.0	2017	4,725	2,626	55.6
2010	9,753	5,104	52.3	2018	4,124	2,406	58.3

[ŧ] Percent is among those with EBLL (% Venous EBLL= (# Venous EBLL / # All EBLL) × 100)

Michigan Counties

In 2018, for children under 6 years old (Table 11) and among counties with at least six children with venous EBLL:

- The counties with the *lowest* proportion of EBLLs from venous tests were Jackson (24.1%), Branch (28.0%), and Saint Clair (28.3%).
- Thirteen counties (including Detroit) had higher EBLL percentages from venous tests than Michigan overall.
- Counties with the *highest* venous EBLL percentages were Berrien (89.7%), Houghton (88.9%), and Washtenaw (78.4%).

Table 11. EBLLs from Venous Blood Lead Tests for Michigan Children Under 6 Years Old, 2018, by County

County	# All EBLL	# Venous EBLL	% Venous EBLL[ǂ]	County	# All EBLL	# Venous EBLL	% Venous EBLL[ǂ]
MICHIGAN	**4,124**	**2,406**	**58.3**	LAKE	*	*	-
ALCONA	*	*	-	LAPEER	21	*	-
ALGER	*	*	-	LEELANAU	0	0	0.0
ALLEGAN	26	10	38.5	LENAWEE	41	25	61.0
ALPENA	6	*	-	LIVINGSTON	6	*	-
ANTRIM	*	*	-	LUCE	*	*	-
ARENAC	*	*	-	MACKINAC	*	*	-
BARAGA	*	0	0.0	MACOMB	88	46	52.3
BARRY	19	6	31.6	MANISTEE	*	*	-
BAY	47	18	38.3	MARQUETTE	16	10	62.5
BENZIE	*	0	0.0	MASON	20	*	-
BERRIEN	39	35	89.7	MECOSTA	*	0	0.0
BRANCH	25	7	28.0	MENOMINEE	8	*	-
CALHOUN	150	93	62.0	MIDLAND	7	*	-
CASS	17	8	47.1	MISSAUKEE	*	*	-
CHARLEVOIX	0	0	0.0	MONROE	18	*	-
CHEBOYGAN	0	0	0.0	MONTCALM	29	11	37.9
CHIPPEWA	*	*	-	MONTMORENCY	0	0	0.0
CLARE	6	*	-	MUSKEGON	154	57	37.0
CLINTON	17	6	35.3	NEWAYGO	*	*	80.0
CRAWFORD	0	0	0.0	OAKLAND	214	97	45.3
DELTA	*	*	-	OCEANA	7	*	-
DICKINSON	*	*	-	OGEMAW	*	*	-
EATON	19	9	47.4	ONTONAGON	*	*	-
EMMET	*	*	-	OSCEOLA	7	*	-
GENESEE	94	41	43.6	OSCODA	0	0	0.0
GLADWIN	*	*	-	OTSEGO	*	0	0.0
GOGEBIC	*	*	-	OTTAWA	61	40	65.6
GRAND TRAVERSE	16	*	-	PRESQUE ISLE	*	*	-
GRATIOT	9	*	-	ROSCOMMON	*	0	0.0
HILLSDALE	22	10	45.5	SAGINAW	95	41	43.2
HOUGHTON	9	8	88.9	SAINT CLAIR	106	30	28.3
HURON	7	*	-	SAINT JOSEPH	42	14	33.3
INGHAM	138	51	37.0	SANILAC	8	*	-
IONIA	46	19	41.3	SCHOOLCRAFT	*	0	0.0
IOSCO	6	*	-	SHIAWASSEE	37	16	43.2
IRON	*	*	-	TUSCOLA	9	6	66.7
ISABELLA	7	*	-	VAN BUREN	20	13	65.0
JACKSON	141	34	24.1	WASHTENAW	37	29	78.4
KALAMAZOO	84	55	65.5	WAYNE, DETROIT	1,407	1,090	77.5
KALKASKA	0	0	0.0	WAYNE, NO DETROIT	311	183	58.8
KENT	330	201	60.9	WEXFORD	*	*	-
KEWEENAW	0	0	0.0	**MICHIGAN**	**4,124**	**2,406**	**58.3**

* Counts between one (1) and five (5) are suppressed (not reported) and replaced with asterisk (*) in the table above to protect the privacy of people who had a blood lead test. Counts are also not reported if they can be used to calculate the suppressed counts.

[ǂ] Percent is among those with EBLLs (% Venous EBLLs = (# Venous EBLLs / # All EBLLs) × 100).

Select Communities

Four selected communities had higher proportions of EBLLs in children under 6 years old detected by venous tests than Michigan overall (Table 12).

- Communities with the *highest* venous EBLL percentages in 2018 were Highland Park (87.0%), Hamtramck (79.0%), and Detroit (77.5%).
- Communities with the *lowest* venous EBLL percentages in 2018 were Jackson (22.7%), Muskegon (35.9%), and Lansing (40.9%).

Table 12. Selected Communities: Number and Proportion of EBLLs from Venous Blood Lead Tests for Michigan Children Under 6 Years Old, 2018

Community	# All EBLL	# Venous EBLL	% Venous EBLL[ŧ]
ADRIAN	23	15	65.2
DETROIT	1,407	1,090	77.5
FLINT	78	38	48.7
GRAND RAPIDS	277	171	61.7
HAMTRAMCK	62	49	79.0
HIGHLAND PARK	46	40	87.0
JACKSON	119	27	22.7
LANSING	115	47	40.9
MUSKEGON	145	52	35.9
MICHIGAN	**4,124**	**2,406**	**58.3**

[ŧ] Percent is among those with EBLLs (% Venous EBLLs = (# Venous EBLLs / # All EBLLs) × 100)

Highest Blood Lead Levels

Children with a venous BLL of 45 µg/dL or higher may require immediate medical treatment, called chelation, to remove lead from the body. In 2018, there were 13 children in Michigan with venous BLLs ≥ 45 µg/dL (Table 13). These children were in Detroit and Alger, Bay, Calhoun, Ionia, Lenawee, Macomb, Saginaw, and Wayne (outside of Detroit) counties; most of these children lived in the city of Detroit (data not shown for privacy).

Since 2003, the number of children under 6 that may require chelation has been 33 or fewer in each year. There have been 15 or fewer children with high lead levels per year since 2010.

Table 13. Michigan Children Under 6 Years Old with Venous Blood Lead Levels Typically Requiring Chelation (≥40 µg/dL) by Year, 2003 – 2018

Year	# Tested	# Venous ≥45 µg/dL	% Venous ≥45 µg/dL[ŧ]	Year	# Tested	# Venous ≥45 µg/dL	% Venous ≥45 µg/dL[ŧ]
2003	100,356	33	0.03	2011	152,331	14	0.01
2004	125,464	33	0.03	2012	149,075	9	0.01
2005	133,488	30	0.02	2013	148,694	13	0.01
2006	141,454	20	0.01	2014	144,182	8	0.01
2007	149,874	16	0.01	2015	141,759	9	0.01
2008	153,268	24	0.02	2016	158,038	7	<0.01
2009	154,567	12	0.01	2017	150,456	8	0.01
2010	156,006	15	0.01	2018	142,387	13	0.01

[ŧ] Percent is among those tested (% Venous EBLL ≥ 45 µg/dL = (# Venous EBLL ≥45 µg/dL / # Tested) × 100)

Discussion

This section presents an interpretation of the results of this report as a whole. For answers to specific questions about this report, see Appendix 1: Frequently Asked Questions and Additional Resources or contact MDHHS-CLPPP@Michigan.gov.

Blood Lead in Michigan

The percentages of tested children with an EBLL and a high EBLL have decreased since 2003; this indicates progress. However, current EBLL percentages and the fact that *any* children may have needed chelation demonstrate that many Michigan children continue to be exposed to lead. This may be due to the age of Michigan homes, lack of parent/guardian home ownership, and the expense of safe lead removal.

Primary prevention – removing sources of lead in the child's environment *before* they have an EBLL – is the most effective way to prevent EBLLs in children.[2,6,10,20] Due to limited resources, Michigan's local health departments focus on secondary prevention, meaning that services are provided only after a child is found to have an EBLL.

Older housing poses the most substantial risk for child lead exposure. The MDHHS Healthy Homes Section provides environmental investigations and lead abatement of homes statewide, to maximize the number of children residing in lead-safe housing in Michigan. Beginning in 2017, the Centers for Medicaid and Medicare Services (CMS) approved a Health Services Initiative supporting environmental investigations and home abatement for eligible households. As such, through a direct service and community-based service models, the Healthy Homes Section achieved over a 400% increase in the number of homes receiving environmental

investigations and abatement beginning in fiscal year 2018. The Healthy Homes Section continues to work closely with CLPPP to ensure that homes occupied by a child with an elevated lead level are of highest priority, and the Section continues to provide lead abatement services within high-risk communities as primary prevention, as well.

Areas with the Highest Burden

Compared to other areas in Michigan, Detroit continued to bear the greatest burden of lead in 2018. Detroit had the highest number of children with an EBLL, one of the highest percentages of children with an EBLL, and the highest number of children who may have needed chelation. This is likely because Detroit has many children living in poverty and older housing, which increases their risk of lead exposure.[4,6,14] Other selected communities also have higher percentages of children with EBLL compared to Michigan overall, particularly the cities of Highland Park and Muskegon. Based on this information, MDHHS plans to continue funding efforts in these areas to reduce lead exposure.

Challenges and Limitations

Blood Lead Surveillance and Data Quality

Findings in this report are subject to the following limitations related to the blood lead surveillance system.

Blood Lead Test Submission

- While law states that test results are to be submitted to MDHHS CLPPP within five business days (see Michigan's Public Health Code MCL 333.20531), many tests are reported months and sometimes years after they were done. This lag in reporting is the main reason that the CLPPP annual report is not released earlier.
- Many labs submit test results to CLPPP in a way that requires manual processing. This increases processing time and is prone to errors. Transitioning more labs to electronic messaging will increase data quality and decrease processing times.

Data Limitations

- When a child has more than one blood lead test, a computer algorithm uses information like name and date of birth to link each test result to the same child. However, the algorithm is not perfect. Errors in spelling of names, dates of birth, and other information may cause the linkage to fail, making it appear that the tests were for more than one child. In this way, some children may be counted more than once per year.
- Laboratories across Michigan do not report race and ethnicity information in a consistent way, so it is currently unavailable for this report. CLPPP is working to provide this data in future reports (see Future Steps).
- This report and previous reports used the address reported by the parent and included on the test result sent by the laboratory, which is usually a mailing address. These addresses were not verified or geocoded until November 2017. Cities in this report are from the mailing address. They do not represent geocoded municipalities that are not part of a mailing address (like townships). For example, addresses in Delta Township will be counted the in Lansing because Lansing is in the mailing address.

Interpretation of Results

- Michigan does not have mandatory blood lead testing, except for testing of children enrolled in Medicaid[15] and WIC.[‡‡] Instead, a child's healthcare provider *recommends* a blood lead test based on their professional judgement of the child's risk - this is targeted testing.
  - The true *number* of children with an EBLL is probably higher than reported because not all children are tested.
  - The true *percentage* of tested Michigan children with an EBLL may be lower than reported due to targeted testing practices.
  - Results in this report are not representative of all children in the state, counties, or selected communities. Children who were tested may have different characteristics (like age, race and ethnicity, or Medicaid status) and may have been exposed to different risk factors (like poverty and living in older housing), than children who were not tested.
    - For example: In 2018, 65.7% of *tested* children under 6 years old were enrolled in Medicaid, while 49.3% of *all* Michigan children under 6 years old are enrolled in Medicaid (Table 2).
  - Interpretation of EBLL percentages between groups of children is difficult because of the difference in testing rates and underlying risks of lead exposure.
- Capillary blood lead tests are known to produce false positives,[21] where a test result indicates that the lead level is higher than it truly is. 41.7% of EBLLs were from these types of tests in 2018.
- Comparisons of EBLL percentages between years should be interpreted with caution for the reasons listed previously (see Limitations of Year-to-Year Comparisons).
- CLPPP reports on the number of Medicaid children under 6 years old tested in that year. Medicaid requires that enrolled children be tested before their third birthday.[15] Medicaid testing rates published in this report should not be used to determine how well Michigan physicians are complying with the Medicaid testing requirement.

Comparing Findings with Other Lead Reports

- Other agencies periodically obtain CLPPP data for their own analyses. Their results may not be the same as those reported by MDHHS CLPPP. This may be because they use different methods to determine the population, total number of children tested, which test chosen for each child for the year (deduplication), and the definition of an EBLL. These inconsistencies can make it difficult to compare results between agency reports.
- The CLPPP dataset is constantly updated to reflect new information. Analysis methods are continually being improved. This means that information about past years presented in this report may not exactly match the information from past reports. The most complete information is always contained in the most recent report.

[‡‡] MCL 400.111l http://legislature.mi.gov/doc.aspx?mcl-400-111l

Future Steps

CLPPP Programmatic Activities

CLPPP will continue activities throughout the state with the goal of further reducing blood lead levels and overall lead exposure. Highlights include:

- Continued and improved training and technical assistance to help local health departments and other partners provide services to children with an EBLL.
- Continued work with Medicaid, health care providers, and local health departments to stress the importance of the confirmatory venous blood tests.
- Routinely assisting local health departments in obtaining Medicaid reimbursement covering the cost of in-home nursing case management for Medicaid children with venous confirmed EBLLs. This should lead to more children receiving these services.

Continue work with local health departments and other agencies to:

- Increase the number of children tested overall.
- Reduce number of children exposed to lead (reduce number with an EBLL).
- Support services for children with an EBLL to identify and remove sources of lead and mitigate negative effects of exposure.
- Increase the percentage of children with capillary EBLLs receiving a subsequent confirmatory venous test.

Improvements to the CLPPP Surveillance Database

- Progress towards obtaining race and ethnicity: CLPPP has recently made progress towards providing this information by getting permission from Michigan Vital Records to use the race and ethnicity information collected at birth. Race and ethnicity information are planned to be available in the 2019 annual report.
- Unique identifier change: The MDHHS Data Warehouse uses a computer algorithm to assign a unique identifying number to all individuals. CLPPP uses the identifier to link multiple test results from the same person and links blood lead test results to records from other MDHHS programs like the Michigan Care Improvement Registry (MCIR) and Medicaid. CLPPP will switch from the previous algorithm to a new algorithm to generate the unique identifier in 2020; the 2019 annual report will use this new identifier. CLPPP has validated this new algorithm to make sure that it works as well or better than the previous algorithm.
- Increased reporting efficiency: laboratories can now submit blood lead test results through electronic messages that are directly imported to MiCLPS. This reduces processing time and errors, allowing more time for additional data cleanup. As of December 31, 2018, seven laboratories were reporting blood lead test results in this way.

Improving Laboratory Reporting and Surveillance Data Analysis

CLPPP has begun several initiatives to improve accuracy and timeliness of reporting, including:

- Helping more laboratories adopt optimal electronic reporting of test results, thereby improving data quality and freeing CLPPP staff to focus on other initiatives.
- Producing quarterly ‘report cards’ for laboratories that submit data to CLPPP. Ideally, increased feedback will lead to improvements in the quality of information reported to CLPPP. Measures may include:
    - Timeliness of submitting test results

- Number of test results that did not meet state-mandated reporting requirements (meaning that key information was missing, incomplete, or incorrect)

CLPPP is undertaking a number of initiatives to provide more useful data summaries for public health officials and the public, including:

- Providing local health departments with regular updates of confirmatory testing rates to inform new and existing interventions to increase confirmatory testing.
- Forming a data users' group. This group of representatives from local health departments and other partners will aid CLPPP in determining what information is most important to produce, in what order, and best way to present it. The goal is that future CLPPP reports will be more useful and easier to understand.
- Continuing to improve analysis and data quality practices, including better address cleanup, laying groundwork to speed up analysis times, and synchronizing reports.
- Expanding analyses, such as identifying factors like household or neighborhood characteristics that can be used to identify high-risk groups in Michigan for targeted interventions.

Appendix 1: Frequently Asked Questions and Additional Resources

Where can I find more information about lead?

Good resources on the web include:

- Michigan.gov/Lead/, Michigan.gov/Leadsafe, or Michigan.gov/Mileadsafe
- www.cdc.gov/nceh/lead/default.htm
- www.epa.gov/lead

What if I am concerned that I or my child was exposed to lead?

Contact your primary care provider or local health department to see if a blood lead test is right for you. You can use the MDHHS Local Health Department Map to find contact information for your local health department.

What does MDHHS CLPPP do for children with elevated blood lead levels (EBLLs)?

Every week, CLPPP alerts local health departments of any child who has an EBLL. The local health departments follow up with the child and their caregivers, providing any or all of the following services:

- Providing information about lead, identifying and removing sources of lead in the home, their child's test result and what it means for their health, and approaches to reduce any negative health effects from lead exposure (like good nutrition).
- Encouragement to get a confirmatory venous test (if needed).
- In-home nursing case management (NCM), which includes at least two home visits to look for lead hazards, assessing the child's growth and development, and educating caregivers on nutrition and cleaning to reduce lead and its effects.
- Referral to other programs. These may include the MDHHS Lead Safe Home Program, for help with identification and safe removal of lead in the home; WIC, for help with the child's nutrition; and other services.

CLPPP supports LHDs' NCM activities by staffing a nurse consultant for training, expertise, and consultations; providing a web-based application to track nursing case management activities; and managing the system for LHDs to obtain reimbursement for NCM services provided to Medicaid children.

MDHHS CLPPP works to increase lead awareness and testing through education and outreach to different target audiences and partners, including foster care programs, health care providers, parents of young children, daycares, schools, landlords, and homeowners. CLPPP provides lead poisoning prevention materials with information on safe cleaning, nutrition, blood lead testing, safe renovations and lead facts. Additionally, CLPPP provides grants to local health departments to provide targeted education and outreach within their regions of the state.

What do you mean by "percent elevated" or "percent EBLL"?

Blood lead test information is presented in whole numbers and in percentages. The percent EBLL is the proportion of children with a blood lead test result of 5 µg/dL or higher *among the children who were tested* for that geography. This is NOT the proportion among all children in that geography. CLPPP cannot accurately determine the proportion of all children who have an EBLL because not all children are tested for blood lead.

For example, it is accurate to say that "Among those tested for lead, 7.4% of Detroit children under 6 years old had an elevated blood lead level.", or "7.4% of Detroit children under 6 years old who were tested for lead had

elevated levels." It is **NOT accurate** to say that "7.4% of Detroit children less than 6 have elevated blood lead levels".

What is the difference between the venous blood lead level categories?

Venous test results are summarized using five categories of blood lead level: 5 to 9 µg/dL, 10 to 14 µg/dL, 15 to 19 µg/dL, 20 to 39 µg/dL, and ≥45 µg/dL. These categories were chosen to meet the needs of local health departments across Michigan. A child qualifies for services regardless of which category they fall into. However, they may be pursued more aggressively and offered more extensive services by the local health department if they have a higher blood lead level.

The most important distinction is for the last group, children with ≥45 µg/dL of lead in the blood who need immediate treatment for acute lead poisoning. A clinician will decide the most appropriate treatment while the local health department will be very aggressive in providing services to remove the source of lead as soon as possible.

Why do you suppress data? What if I need data that has been suppressed?

CLPPP suppresses some data (replaces it with an asterisk (*) in the tables) to maintain the privacy of people who had a blood lead test. The idea is that if there are fewer than six people tested in an area (zip code, city, or county), it might be possible to identify the person or people tested and their result(s). Suppressing counts less than six is a common practice for similar types of reports. CLPPP will release unsuppressed counts to local health departments upon request.

Why are the counts for 2018 (or earlier years) different from the 2017 (or earlier) annual report?

CLPPP's database is continuously updated with any new test results that are submitted; this can include results that were not reported in time for prior years' reports. CLPPP also works to improve data quality and the analysis process each year. Therefore, counts may change slightly from what was reported previously.

How can I get other blood lead testing information from CLPPP?

The most up-to-date blood lead testing data can be found on Michigan.gov/Mitracking. Data with interpretation and context are in the CLPPP annual reports and supplemental documents, available on the web at Michigan.gov/Lead, on the Lead Data and Reports webpage., If other information is needed, please email MDHHS-CLPPPDATA@Michigan.gov. The CLPPP team can provide non-identifiable summary data (counts and percentages); they may ask you to fill out a data request form to better understand your needs. If the information needed is not summary-level (i.e., not aggregated, with information about individual tests or children) or is needed for research purposes, a Data Use Agreement and/or Institutional Review Board (IRB) approval may be required.

Who do I contact if I have other questions about this report?

Feel free to send an email directly to CLPPP at MDHHS-CLPPP@michigan.gov.

Appendix 2: Technical Information about Data Analysis

Data Elements

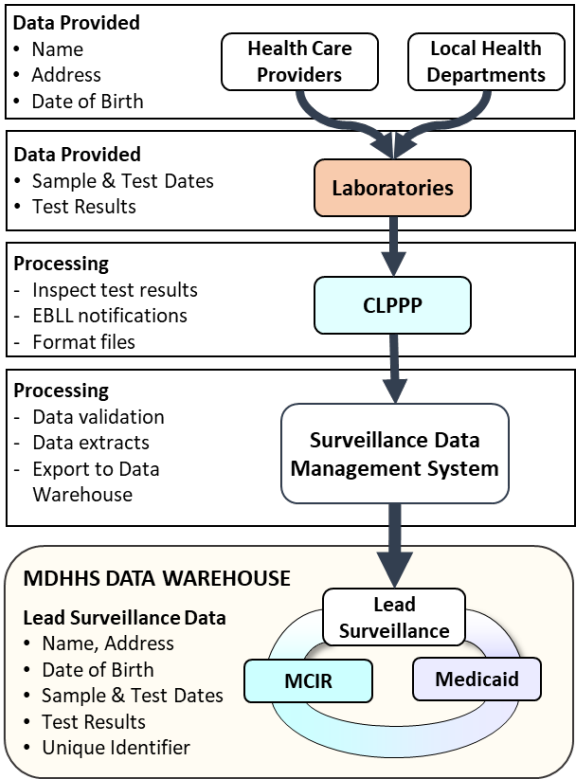
Table 14. Contents of MiCLPS, the Michigan CLPPP Surveillance Database

Type of Data	Description
Patient Information	Name, Residential Address, Date of Birth, Sex, Race*, Ethnicity*, Parent/Guardian Contact Information, Social Security Number, Medicaid ID Number (if applicable)
Testing Information	Ordering Physician Contact Information, Laboratory Contact Information, Blood Lead Test Number, Date of Sample Collection, Date of Testing, Type of Blood Sample, Test Result

*Many laboratories do not consistently or correctly report this information. Therefore, it is considered unreliable.

Data Flow and Data Quality

Figure A. Blood Lead Data Flow



Results and other information flow from the patient to CLPPP and partners as illustrated in Figure A. Typically, information about the patient and blood samples are collected at a doctor's office or health department. Then, the blood is tested on-site by a portable blood lead analyzer or sent to a laboratory. All blood lead test results must be submitted to the MDHHS CLPPP (see Michigan's Public Health Code MCL 333.20531) within five working days after test completion.

CLPPP receives data from laboratories in a variety of formats, including HL7 messages and Excel spreadsheets. They are then uploaded each week to CLPPP's database, called MiCLPS (Michigan Childhood Lead Poisoning Surveillance). A unique identifier is assigned to each test, called the serial number. Priority datapoints are manually reviewed and submitting laboratories/ordering physicians are contacted to fix errors. This does not include changing blood lead test results but includes corrections for inconsistencies in dates (for example, testing date is before the child's date of birth), incomplete addresses, and other errors. Starting in November 2017, addresses are also automatically validated and geocoded by a computer algorithm, when possible.

After the first phase of data cleanup is completed (includes the first step of Address Processing), data are uploaded each week to the MDHHS Data Warehouse. This is the place where health data collected by MDHHS is stored. A computer algorithm then links all blood lead tests for the same child together by assigning a unique identifier to each child. This also links blood lead test results to the child's Medicaid information and the state's immunization registry (MCIR, Michigan Care Improvement Registry). This allows health care providers to see their patient's lead level when the child's immunization record is opened in MCIR.

This database is updated continuously as laboratories submit new blood lead tests or any corrections to old tests, so that it always has the most current information. As new information is incorporated, CLPPP identifies and

corrects errors with the help of the submitting laboratories. Further data cleanup is done at the time of analysis and report creation.

Address Processing

Addresses are reported to CLPPP by the testing laboratory and loaded into MiCLPS. The following process is currently used to verify and geocode addresses:

1. When addresses are loaded into MiCLPS, they are verified using geocoding from the State of Michigan's Center for Shared Solutions (CSS).
    a. If an address is correct, it is not changed. County is assigned using the geocoding software.
    b. If the address is incorrect but of good enough quality, it is automatically corrected and the county is assigned using the geocoding software. In 2018, over 98% of addresses reported to CLPPP were of good quality and able to be geocoded.
    c. If the address is missing or of poor quality, it is flagged for manual review by CLPPP staff. To obtain the correct address:
        i. CLPPP contacts the submitting laboratory for the address.
        ii. If the submitting laboratory does not respond and the child is enrolled in Medicaid, CLPPP staff uses information from the Medicaid record to correct the address and assign county.
        iii. If the above is unsuccessful or the child is not enrolled in Medicaid, CLPPP staff uses information from MCIR to correct the address and assign county.
        iv. If all steps above are unsuccessful, CLPPP assigns the county of the testing laboratory to the test result and leaves the rest of the address fields as they are. This is rare.
2. Records are sent to the MDHHS data warehouse.
3. When records are extracted for analysis, addresses are further cleaned and standardized. This is primarily done to correct records collected before the automatic verification and geocoding was put into place in November 2017.
    a. Out-of-state records are removed from analysis. These are records have a city, ZIP code, or county placing them in another state (for example, city of Cleveland).
    b. Records with insufficient address information are removed from analysis. These include records with no reported city, ZIP code, and county.
    c. Common spelling errors are fixed (for example, "Washtenau" county is corrected to "Washtenaw" county).
    d. Corrections from manual address review are applied (for example, records with city of Grand Rapids are assigned to Kent county).

Housing Stock and Population Estimates

The U.S. Census American Community Survey (ACS) produces estimates of socioeconomic and housing characteristics, which are available through the Census Factfinder (https://data.census.gov/). These estimates describe the average characteristics of an area (such as a state, county, or city) over a specific period of time. This analysis used five-year estimates when available, which are considered to be more accurate than one-year estimates because five years of data are used. For example, a 2018 5-year estimate is based on data collected from January 2014 to December 2018. It can also be written as a 2014-2018 5-year estimate. For more information, see the ACS General Handbook at https://www.census.gov/content/dam/Census/library/publications/2008/acs/ACSGeneralHandbook.pdf

Population by year of age are based on estimates using data from the 2010 decennial census, also available from the Census Factfinder. For data before 2011, population estimates are available from the National Center for

Health Statistics, which produces bridged-race population estimates. These estimates were downloaded from the National Vital Statistics System (NVSS) website: https://www.cdc.gov/nchs/nvss/bridged_race.htm.

Source tables used in this analysis were:

- Housing age in 2018: The 2014-2018 ACS 5-year estimate for 2018, table B25034 (Year Structure was Built)
- Yearly population estimates for children under 6 years old in 2009 – 2018: ACS 5-year estimates, table B09001 (Population Under 18 Years of Age)
- Yearly population estimates for children under 6 years old in 2003 – 2008: NVSS 2010 bridged-race population estimates
- Population of children under 6 years old with certain demographic characteristics in 2018: U.S. Census 2018 table PEPSYASEX (Annual Estimates of the Resident Population by Single Year of Age and Sex for the United States, States, and Puerto Rico Commonwealth)

Software

Summary-level data was generated using SAS 9.4. Tables were formatted and graphs generated using Microsoft Excel 2010. Maps were made with Arc GIS 10.7.1.

More about Deduplication

Children often receive more than one test per year. In order to summarize the data in counts of children and not counts of tests, tests were deduplicated by keeping the highest and most accurate test value. If a child had multiple tests within a calendar year:

1. The highest BLL obtained from a venous test was used.
2. If no venous test was performed, the highest BLL obtained from a capillary test was used.
3. If the only test results had unknown sample type, then the highest of these results was used.

For example: A child had a capillary test with a result of 9 µg/dL in January. Since this test was elevated, their doctor ordered a confirmatory venous test in February, which came back at 5 µg/dL. After receiving case management services, a follow-up venous test was done in June to see if the interventions worked. The result was 3 µg/dL. According to the algorithm, the venous test at 5 µg/dL would be kept and the child would be counted as elevated in the summary data.

Meaning of an Elevated Result

An EBLL is a blood lead test result ≥ 5 µg/dL, the reference value currently recommended by the CDC. This value is based on the 97.5th percentile of BLLs in children 1 to 5 years old in the United States according to the 2007-2010 National Health and Nutrition Examination Survey (NHANES).[2] This means that only 2.5% of surveyed children had blood lead levels greater than or equal to 5 µg/dL.

More about Rounding and the Limit of Detection

Prior to November 2017, the CLPPP surveillance database has followed the requirements specified by Administrative Rule R 325.9082. This states that blood lead test results are to be reported as whole numbers, rounded to the nearest whole number. Starting in November 2017, the CLPPP database was changed to collect non-rounded results and indications that a result is below the limit of detection (limit of reporting). (Note these Rules are being amended to reflect current practice as described here).

Prior to this change, a child with a result between 4.5 and 4.9 µg/dL would have been reported to CLPPP as 5 µg/dL and they would have qualified for nursing case management services. To keep the same level of service as in the past and to keep the data analysis consistent, CLPPP rounds all values for reporting and considers a value of 4.5 µg/dL to be an elevated result.[1]

Point-of-care testing has a limit of detection at 3.3 µg/dL. Before this change, a result below this limit of detection was rounded down and reported as 3 µg/dL. Other testing methods are more precise and can have results equal to 3 µg/dL. This means that the CLPPP database was unable to distinguish between a result below 3 µg/dL and equal to 3 µg/dL. Now, the less-than sign (<) is stored with these test results, allowing for identification of results below the limit of detection.

History of Blood Lead Testing and Requirements

- Since 1989, the U.S. Centers for Medicare and Medicaid Services (CMS) has required lead testing for all children enrolled in Medicaid. At the time, CMS did not allow states to modify this requirement.[19,22]
- From 1978 to 1997, the CDC recommended universal testing for all children under 6 years old.[23]
- In 1997, the CDC recommended that states move away from universal testing for all children under 6 years old. Instead, they recommended testing children at highest risk. Since children enrolled in Medicaid are at higher risk, they recommended that all children enrolled in Medicaid still be tested for lead before their third birthday.[19,22]
- In 2004, Michigan passed legislation requiring that 80% of children enrolled in Medicaid be screened by 2007, further enforcing compliance with the federal testing requirement (see MCL 400.111k).
- In 2006, the Food and Drug Administration approved point-of-care capillary blood lead testing, expanding capillary blood lead testing.[24]
- In 2012, the blood lead level considered to be "elevated" changed from 10 µg/dL to 5 µg/dL[2]. As a result, venous follow-up testing was recommended at lower blood lead levels than before.
- In 2016, there was increased blood lead testing across the entire state, likely due to increased public awareness about lead because of the Flint water crisis (Figure 1).

Appendix 3: Reference Data Tables

Table Appx 1. Blood Lead Testing and Levels for Children Under 6 Years Old by County of Residence and Sample Type, 2018, Data Suppressed*

County	% Pre-1950 Homes‡	% Pre-1980 Homes‡	Population Children < 6‡	# Tested	% Tested[A]	# EBLL	% EBLL[B]	# Capillary† EBLL	% Capillary† EBLL[B]	# Venous EBLL	% Venous EBLL[B]
ALCONA	20.5	71.4	384	95	24.7	*	-	*	-	*	-
ALGER	16.1	61.7	439	61	13.9	*	-	*	-	*	-
ALLEGAN	11.9	44.8	8,537	1,322	15.5	26	2.0	16	1.2	10	0.8
ALPENA	23.4	69.5	1,567	320	20.4	6	1.9	*	-	*	-
ANTRIM	13.1	58.4	1,220	277	22.7	*	-	*	-	*	-
ARENAC	16.9	62.1	816	211	25.9	*	-	*	-	*	-
BARAGA	17.3	58.2	468	126	26.9	*	-	*	-	0	0.0
BARRY	14.0	46.9	3,954	386	9.8	19	4.9	13	3.4	6	1.6
BAY	26.2	60.8	6,200	1,296	20.9	47	3.6	29	2.2	18	1.4
BENZIE	12.8	47.4	959	253	26.4	*	-	*	-	0	0.0
BERRIEN	23.7	59.6	10,844	1,565	14.4	39	2.5	*	-	*	-
BRANCH	14.9	49.9	3,286	373	11.4	25	6.7	18	4.8	7	1.9
CALHOUN	23.1	55.2	9,739	2,608	26.8	150	5.8	57	2.2	93	3.6
CASS	18.6	54.1	3,042	363	11.9	17	4.7	9	2.5	8	2.2
CHARLEVOIX	16.2	57.7	1,421	236	16.6	0	0.0	0	0.0	0	0.0
CHEBOYGAN	11.7	52.3	1,228	247	20.1	0	0.0	0	0.0	0	0.0
CHIPPEWA	18.5	51.9	2,229	409	18.3	*	-	*	-	*	-

Data is current as of 3/6/2020.

* Counts between one (1) and five (5) are suppressed (not reported) and replaced with a * in the table above. Other counts are also not reported if they can be used to calculate the suppressed counts. This is done to protect the privacy of people who had a blood lead test.

‡ US Census data from American Community Survey tables B09001 (numbers of children living in households) and B25034 (house age).

† Includes tests with unknown sample type.

[A] Percent is among population of children less than six years old (% Tested= # All Tested/Population * 100).

[B] Percent is among all tested children less than six years old (% Tested= # in EBLL category/# Tested * 100).

Table Appx 1. Blood Lead Testing and Levels for Children Under 6 Years Old by County of Residence and Sample Type, 2018, Data Suppressed*

County	% Pre-1950 Homes‡	% Pre-1980 Homes‡	Population Children < 6‡	# Tested	% Tested[A]	# EBLL	% EBLL[B]	# Capillary† EBLL	% Capillary† EBLL[B]	# Venous EBLL	% Venous EBLL[B]
CLARE	15.9	63.0	2,020	410	20.3	6	1.5	*	-	*	-
CLINTON	10.6	46.2	5,149	680	13.2	17	2.5	11	1.6	6	0.9
CRAWFORD	15.3	65.7	705	113	16.0	0	0.0	0	0.0	0	0.0
DELTA	18.0	53.3	2,199	318	14.5	*	-	*	-	*	-
DICKINSON	18.7	55.5	1,546	221	14.3	*	-	*	-	*	-
EATON	10.7	54.2	7,479	1,099	14.7	19	1.7	10	0.9	9	0.8
EMMET	9.8	49.7	1,834	305	16.6	*	-	0	0.0	*	-
GENESEE	26.4	66.6	29,030	6,362	21.9	94	1.5	53	0.8	41	0.6
GLADWIN	15.9	61.2	1,572	297	18.9	*	-	*	-	*	-
GOGEBIC	16.1	48.7	681	162	23.8	*	-	*	-	*	-
GRAND TRAVERSE	8.7	45.7	5,690	1,463	25.7	16	1.1	*	-	*	-
GRATIOT	20.9	53.5	2,433	412	16.9	9	2.2	*	-	*	-
HILLSDALE	12.2	47.4	3,173	564	17.8	22	3.9	12	2.1	10	1.8
HOUGHTON	12.0	38.4	2,346	500	21.3	9	1.8	*	-	*	-
HURON	22.3	58.8	1,908	369	19.3	7	1.9	*	-	*	-
INGHAM	20.9	61.6	19,749	4,608	23.3	138	3.0	87	1.9	51	1.1
IONIA	12.7	45.0	4,434	968	21.8	46	4.8	27	2.8	19	2.0
IOSCO	25.4	70.0	1,323	286	21.6	6	2.1	*	-	*	-
IRON	21.7	51.8	554	122	22.0	*	-	0	0.0	*	-

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‡ US Census data from American Community Survey tables B09001 (numbers of children living in households) and B25034 (house age).

† Includes tests with unknown sample type.

[A] Percent is among population of children less than six years old (% Tested= # All Tested/Population * 100).

[B] Percent is among all tested children less than six years old (% Tested= # in EBLL category/# Tested * 100).

Table Appx 1. Blood Lead Testing and Levels for Children Under 6 Years Old by County of Residence and Sample Type, 2018, Data Suppressed*

County	% Pre-1950 Homes‡	% Pre-1980 Homes‡	Population Children < 6‡	# Tested	% Tested[A]	# EBLL	% EBLL[B]	# Capillary† EBLL	% Capillary† EBLL[B]	# Venous EBLL	% Venous EBLL[B]
ISABELLA	10.2	48.2	3,971	690	17.4	7	1.0	*	-	*	-
JACKSON	20.3	52.5	10,937	2,907	26.6	141	4.9	107	3.7	34	1.2
KALAMAZOO	19.3	57.4	18,784	3,194	17.0	84	2.6	29	0.9	55	1.7
KALKASKA	11.2	59.9	1,080	202	18.7	0	0.0	0	0.0	0	0.0
KENT	17.4	53.6	52,387	9,490	18.1	330	3.5	129	1.4	201	2.1
KEWEENAW	10.3	29.6	114	22	19.3	0	0.0	0	0.0	0	0.0
LAKE	9.9	62.1	572	136	23.8	*	-	*	-	*	-
LAPEER	10.9	54.0	5,302	932	17.6	21	2.3	*	-	*	-
LEELANAU	8.7	47.1	1,062	272	25.6	0	0.0	0	0.0	0	0.0
LENAWEE	18.8	47.5	6,231	1,148	18.4	41	3.6	16	1.4	25	2.2
LIVINGSTON	8.7	45.1	11,692	1,075	9.2	6	0.6	*	-	*	-
LUCE	20.0	65.8	306	79	25.8	*	-	*	-	*	-
MACKINAC	16.0	53.9	496	119	24.0	*	-	0	0.0	*	-
MACOMB	22.3	67.4	57,406	12,177	21.2	88	0.7	42	0.3	46	0.4
MANISTEE	15.0	54.3	1,158	275	23.7	*	-	*	-	*	-
MARQUETTE	19.0	60.1	3,922	456	11.6	16	3.5	6	1.3	10	2.2
MASON	15.8	51.9	1,788	452	25.3	20	4.4	*	-	*	-
MECOSTA	9.8	55.4	2,496	391	15.7	*	-	*	-	0	0.0
MENOMINEE	21.8	53.9	1,314	230	17.5	8	3.5	*	-	*	-
MIDLAND	19.7	64.7	5,561	404	7.3	7	1.7	*	-	*	-

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‡ US Census data from American Community Survey tables B09001 (numbers of children living in households) and B25034 (house age).

† Includes tests with unknown sample type.

[A] Percent is among population of children less than six years old (% Tested= # All Tested/Population * 100).

[B] Percent is among all tested children less than six years old (% Tested= # in EBLL category/# Tested * 100).

Table Appx 1. Blood Lead Testing and Levels for Children Under 6 Years Old by County of Residence and Sample Type, 2018, Data Suppressed*

County	% Pre-1950 Homes‡	% Pre-1980 Homes‡	Population Children < 6‡	# Tested	% Tested[A]	# EBLL	% EBLL[B]	# Capillary† EBLL	% Capillary† EBLL[B]	# Venous EBLL	% Venous EBLL[B]
MISSAUKEE	15.2	58.8	1,132	132	11.7	*	-	*	-	*	-
MONROE	20.7	52.9	9,631	1,468	15.2	18	1.2	*	-	*	-
MONTCALM	15.4	50.7	4,288	796	18.6	29	3.6	18	2.3	11	1.4
MONTMORENCY	18.6	76.1	394	80	20.3	0	0.0	0	0.0	0	0.0
MUSKEGON	25.7	58.8	12,718	2,660	20.9	154	5.8	97	3.6	57	2.1
NEWAYGO	14.4	54.4	3,440	510	14.8	*	-	*	-	*	-
OAKLAND	22.5	66.7	82,634	16,312	19.7	214	1.3	117	0.7	97	0.6
OCEANA	12.7	51.3	1,880	467	24.8	7	1.5	*	-	*	-
OGEMAW	17.6	62.2	1,159	215	18.6	*	-	*	-	*	-
ONTONAGON	19.8	51.9	162	42	25.9	*	-	*	-	*	-
OSCEOLA	10.5	62.7	1,472	338	23.0	7	2.1	*	-	*	-
OSCODA	20.9	75.4	481	80	16.6	0	0.0	0	0.0	0	0.0
OTSEGO	10.4	61.3	1,560	250	16.0	*	-	*	-	0	0.0
OTTAWA	12.3	49.6	21,745	3,092	14.2	61	2.0	21	0.7	40	1.3
PRESQUE ISLE	21.5	65.6	549	76	13.8	*	-	0	0.0	*	-
ROSCOMMON	18.0	71.0	1,020	210	20.6	*	-	*	-	0	0.0
SAGINAW	23.5	65.7	13,122	3,139	23.9	95	3.0	54	1.7	41	1.3
SAINT CLAIR	19.9	54.2	9,668	2,691	27.8	106	3.9	76	2.8	30	1.1
SAINT JOSEPH	19.2	57.8	4,776	988	20.7	42	4.3	28	2.8	14	1.4

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† Includes tests with unknown sample type.

[A] Percent is among population of children less than six years old (% Tested= # All Tested/Population * 100).

[B] Percent is among all tested children less than six years old (% Tested= # in EBLL category/# Tested * 100).

Table Appx 1. Blood Lead Testing and Levels for Children Under 6 Years Old by County of Residence and Sample Type, 2018, Data Suppressed*

County	% Pre-1950 Homes‡	% Pre-1980 Homes‡	Population Children < 6‡	# Tested	% Tested[A]	# EBLL	% EBLL[B]	# Capillaryŧ EBLL	% CapillaryŧEBLL[B]	# Venous EBLL	% Venous EBLL[B]
SANILAC	18.6	53.4	2,648	355	13.4	8	2.3	*	-	*	-
SCHOOLCRAFT	14.2	56.4	417	89	21.3	*	-	*	-	0	0.0
SHIAWASSEE	18.4	55.7	4,145	1,225	29.6	37	3.0	21	1.7	16	1.3
TUSCOLA	17.8	56.2	3,340	730	21.9	9	1.2	*	-	*	-
VAN BUREN	16.0	52.5	5,452	910	16.7	20	2.2	7	0.8	13	1.4
WASHTENAW	15.0	54.9	21,405	2,931	13.7	37	1.3	8	0.3	29	1.0
WAYNE DETROIT	46.1	59.6	58,795	19,973	34.0	1,407	7.0	317	1.6	1,090	5.5
WAYNE NO DETROIT	36.3	72.1	78,870	18,263	23.2	311	1.7	128	0.7	183	1.0
WEXFORD	13.4	52.9	2,346	307	13.1	*	-	0	0.0	*	-
MICHIGAN	**22.8**	**60.0**	**685,986**	**142,387**	**20.8**	**4,124**	**2.9**	**1,718**	**1.2**	**2,406**	**1.7**

Data is current as of 3/6/2020.

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‡ US Census data from American Community Survey tables B09001 (numbers of children living in households) and B25034 (house age).

ŧ Includes tests with unknown sample type.

[A] Percent is among population of children less than six years old (% Tested= # All Tested/Population * 100).

[B] Percent is among all tested children less than six years old (% Tested= # in EBLL category/# Tested * 100).

Table Appx 2. Blood Lead Testing and Levels for Children Under 6 Years Old in Selected Communities and by Sample Type, 2018

Community	% Pre-1950 Homes‡	% Pre-1980 Homes‡	Population Children < 6‡	# Tested	% Tested[A]	# EBLL	% EBLL[B]	# Capillary† EBLL	% Capillary† EBLL[B]	# Venous EBLL	% Venous EBLL[B]
ADRIAN	23.8	48.5	1,442	556	38.6	23	4.1	8	1.4	15	2.7
DETROIT	46.1	59.6	58,795	19,973	34.0	1,407	7.0	317	1.6	1090	5.5
FLINT	42.8	72.5	8,543	3,340	39.1	78	2.3	40	1.2	38	1.1
GRAND RAPIDS	25.1	51.2	17,250	6,053	35.1	277	4.6	106	1.8	171	2.8
HAMTRAMCK	28.0	41.1	2,467	1,210	49.0	62	5.1	13	1.1	49	4.0
HIGHLAND PARK	23.5	45.2	915	310	33.9	46	14.8	6	1.9	40	12.9
JACKSON	23.4	40.6	2,989	2,249	75.2	119	5.3	92	4.1	27	1.2
LANSING	27.9	65.9	9,910	3,686	37.2	115	3.1	68	1.8	47	1.3
MUSKEGON	32.9	56.5	4,301	2,019	46.9	145	7.2	93	4.6	52	2.6
MICHIGAN	**22.8**	**60.0**	**685,986**	**142,387**	**20.8**	**4,124**	**2.9**	**1,718**	**1.2**	**2,406**	**1.7**

Data are current as of 3/6/2020.

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‡ US Census data from American Community Survey tables B09001 (numbers of children living in households) and B25034 (house age).

† Includes tests with unknown sample type.

[A] Percent is among population of children less than six years old (% Tested= # All Blood Samples Tested/Population * 100).

[B] Percent is among all tested children less than six years old (% Tested= # in EBLL category/# Tested * 100).

Appendix 4: References

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