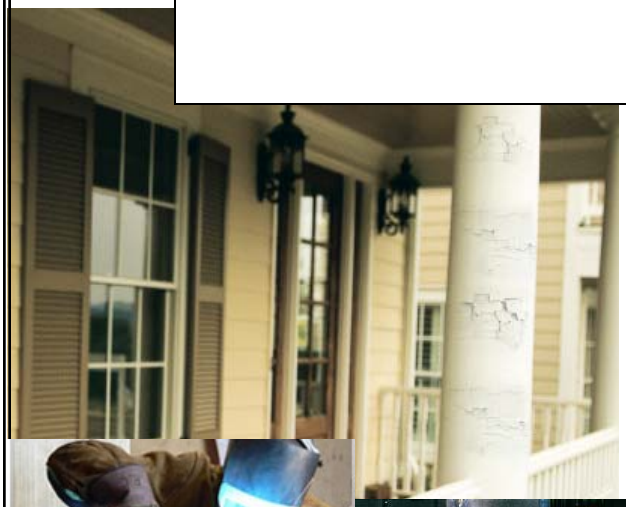
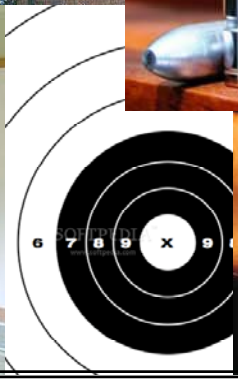
2008

Annual Report on Blood Lead Levels on Adults in Michigan





2008 ANNUAL REPORT

Adult Blood Lead Epidemiology Surveillance (ABLES) Program

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Thanks to the commitment of those health care providers who understand the public health significance of diagnosing a patient with an occupational illness, as well as the Michigan residents who took the time to share their experiences about their exposures and elevated blood lead levels.

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There are many resources available to help employers, employees, health care professionals and others understand more about lead exposure, prevention and medical management. Links to these resources can be found at: **www.oem.msu.edu**.

Acronyms

BLLs Blood Lead Levels

ABLES Adult Blood Lead Epidemiology Surveillance

MDCH Michigan Department of Community Health

CDC Centers for Disease Control and Prevention

CLPPP Childhood Lead Poisoning Prevention Program

MDELEG Michigan Department of Energy, Labor & Economic Growth

MIOSHA Michigan Occupational Safety & Health Administration

MSU Michigan State University

NAICS North American Industrial Classification System

NIOSH National Institute for Occupational Safety & Health

OSHA Occupational Safety & Health Administration (Federal)

SIC Standard Industrial Classification System (1987)

Summary

This is the eleventh annual report on surveillance of blood lead levels (BLLs) of Michigan citizens. It is based on data collected as a result of regulations promulgated October 11, 1997 by the Michigan Department of Community Health (MDCH) to address the health hazard of exposure to inorganic lead. MDCH regulations require laboratories to report all blood lead analyses, both among adults and children. The Adult Blood Lead Epidemiology and Surveillance (ABLES) Program was founded nationally in 1992 and tracks laboratory reports of elevated BLLs in U.S. adults.

This report summarizes BLLs of Michigan adults, defined as sixteen years and older.

In 2008, Michigan ABLES received 15,305 blood lead tests for 13,682 individuals ≥16 years of age. Six hundred and eighty-eight (5.0%)

Summary, continued...

individuals had BLLs ≥ 10 µg/dL; 129 of those 688 had lead levels ≥ 25 µg/dL and seven of the 129 had BLLs ≥ 50 µg/dL.

There were 588 fewer blood lead tests and 903 fewer individuals reported in 2008 compared to 2007. The number and the percent of individuals with BLLs ≥10 µg/dL decreased from 768 (5.3%) in 2007 to 688 (5.0%) in 2008. The number and percent of individuals with BLLs ≥25 µg/dL stayed fairly constant at 130 (0.9%) in 2007 and 129 (0.9%) in 2008 as did the number of individuals with BLLs ≥ 50 µg/dL, with 9 (0.1%) in 2007 and 7 (0.1%) in 2008. For eight consecutive years, from 1999 to 2006, the BLLs ≥25 µg/dL show a decrease from the previous year. In 2007 there was a slight increase; the values for 2008 were down from 2007 but still greater than 2006. These overall changes occurred among both occupational and non-occupational exposures, although the decrease in non-occupational BLLs ≥ 25 µg/dL did not begin until 2004.

The adults with BLLs ≥10 µg/dL were likely to be men (96.1%) and white (89.1%). Their mean age was 44. They were most likely to live in Wayne (20.0%), Montcalm (11.1%) or St. Clair (10.4%) counties.

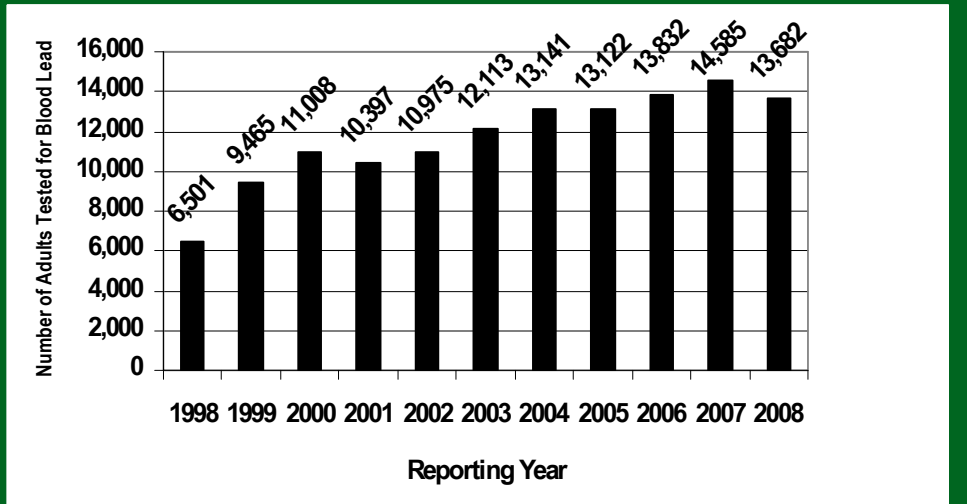
Occupational exposure remains the predominant source of lead exposure in Michigan adults (83.4%). In Michigan, lead exposure resulting in BLLs ≥10 µg/dL typically occurs where individuals: perform abrasive blasting to remove lead paint on outdoor metal structures such as bridges, overpasses or water towers; cast brass or bronze fixtures; fabricate metal products; or are exposed to lead fumes or dust from firing guns or retrieving spent bullets at firing ranges.

Among Michigan adults, lead exposure from firing ranges, as well as reloading and casting activities associated with firearms, is the most common cause of non-occupational exposure (12.3% of all reported cases with blood lead ≥10 µg/dL from known causes; 73.3% of all known non-occupational cases). Firing ranges are a source of lead exposure where members qualify for both work and recreational marksmanship standards in commercial as well as private recreation ranges. Private gun clubs and ranges, run by members and volunteers, are not under the jurisdiction of State regulations as are firing ranges with paid employees. Outreach effort to educate this group of lead-exposed hobbyists remains a challenge.

Occupational exposure remains the predominant source of lead exposure in Michigan adults. Lead exposure resulting in blood lead levels ≥10 µg/dL typically occur where individuals perform abrasive blasting to remove lead paint on outdoor metal structures, cast brass or bronze fixtures; fabricate metal products; or are exposed to lead fumes or dust from firing guns or retrieving spent bullets at firing ranges.

The eleventh year of operation of an adult blood lead surveillance system in Michigan proved successful in continuing to identify individuals with elevated BLLs and sources of exposures that could be remediated to reduce lead exposure. Outreach and intervention activities this past year included follow-up interviews with 136 lead exposed individuals and distributing resources on diagnosis and management of lead exposure to 42 health care providers who tested patients with elevated blood lead levels. A "how to" guide for home maintenance and renovation from the U.S. Department of Housing and Urban Development was provided to individuals, when renovation expo-

Figure 1 **Number of Adults Reported with Tests for Blood Lead, Michigan 1998—2008**



sure to lead was identified. Two educational brochures continued to be distributed this past year: one on working safely with lead and the second on controlling lead exposure in firing ranges. Copies of these brochures and a diagnosis management plan for health care providers are available at www.oem.msu.edu under "Resources for Lead." In addition, information on risk of take home lead exposure was provided to occupationally-exposed adults identified with children under the age of six. Referrals for inspections of 14 Michigan companies were made to the Michigan Occupational Safety and Health Administration (MIOSHA) for either consultation or enforcement inspections in 2008. Details of these inspections are included in this report.

A Federal Occupational Safety and Health Administration (OSHA) directive issued in 2008 requires the follow-up of surveillance reports of BLLs ≥ 25 µg/dL. This new directive was modeled on the experience of Michigan's lead poisoning surveillance, which has been successfully investigating the workplaces of individuals with BLLs ≥ 25 µg/dL for the past 10 years.

Thirty years of lead toxicity research has consistently demonstrated significant health risks from lead exposure at lower levels, especially as sustained in occupational exposure (7-10).

Background

This is the eleventh annual report on surveillance of BLLs in Michigan residents. BLLs of Michigan residents, including children, have been monitored by the state since 1992. From 1992 to 1995, laboratories performing analyses of blood lead levels, primarily of children, were voluntarily submitting reports to the Michigan Department of Public Health and then beginning in 1996 to the Michigan Department of Community Health (MDCH). The MDCH promulgated regulations effective October 11, 1997, that require laboratories to submit reports of both children and adults to the MDCH for any blood testing for lead. Coincident with this, the Michigan Occupational Safety and Health Administration (MIOSHA) in the Michigan Department of Energy, Labor and Economic Growth (MDELEG) received federal funding in 1997 from the Centers for Disease Control and Prevention (CDC), to monitor adult BLLs as part of the ABLES Program. Beginning in 2006, the funds were provided directly to Michigan State University (MSU). Currently 40 states have established lead registries through the ABLES Program for surveillance of adult lead absorption, primarily based on reports of elevated BLLs from clinical laboratories. A copy of the most recent report of adult blood lead surveillance from 38 states, as published in the *Morbidity and Mortality Weekly Report*, April 17, 2009 is provided in this report (Appendix A).

THE MICHIGAN ADULT BLOOD LEAD REGISTRY

Reporting Regulations and Mechanism

Since October 11, 1997, laboratories performing blood lead analyses of Michigan residents are required to report the results of all blood lead level (BLL) tests to the MDCH (R325.9081-.9087 – Appendix B). Prior to these regulations, few reports of elevated lead levels among adults were received.

The laboratories are required to report blood sample analysis results, patient demographics, and employer information on a standard MDCH Lead Reporting Form (Appendix B). The physician or health provider ordering the blood lead analysis is responsible for completing the patient information, the physician/provider information and the specimen collection information. Upon receipt of the blood sample for lead analysis, the clinical laboratory is responsible for completion of the laboratory information. All clinical laboratories conducting business in Michigan that analyze blood samples for lead must report all adult and child blood lead results to the MDCH, Childhood Lead Poisoning Prevention Program (CLPPP) within five working days.

All blood lead results on individuals 16 years or older are forwarded to MSU for a potential interview and then to the Michigan Occupational Safety and Health Administration (MIOSHA) in the MDELEG for work-place follow-up. MSU has been desig-

Background, continued

nated the bona fide agent of the State to conduct this activity. A summary of blood lead results from 2008 on children less than six years old is separate of this report.

Laboratories

Employers providing blood lead analysis on their employees as required by MIOSHA must use an OSHA approved laboratory to be in compliance with the lead standard. The insert below lists these ten Michigan approved laboratories, which have not changed from previous years.

Data Management

When BLL reports are received at the MDCH, they are reviewed for completeness. For those reports where information is missing, copies are returned to the physician/ provider to complete. Lead Registry staff code the information on the lead reporting form using a standard coding scheme and enter this information into a computerized database. Each record entered into the database is visually checked for any data entry errors, duplicate entries, missing data, and illogical data. These quality control checks are performed monthly.

Case Follow-Up

Adults whose BLL is 25 µg/dL or greater are contacted for an interview. Interviews are conducted of individuals with BLLs ranging from 10 to 24 µg/dL if the source of their lead exposure cannot be identified from the reporting form. A letter is sent to individuals explaining Michigan's lead surveillance program and inviting them to answer a 15-20 minute telephone questionnaire about their exposures to lead and any symptoms they may be experiencing. The questionnaire collects patient demographic data, work exposure and history information, symptoms related to lead exposure, information on potential lead-using hobbies and non-work related activities, and the presence of young children in the household to assess possible take-home lead exposures among these children. Trained interviewers administer the questionnaire.

OSHA BLOOD LEAD LABORATORIES*: MICHIGAN

Laboratory Name	*City*	*County*
Detroit Health Department	Detroit	Wayne
DMC University Laboratories	Detroit	Wayne
Hackley Hospital Laboratory	Muskegon	Muskegon
Marquette General Health Systems	Marquette	Marquette
Michigan Department of Community Health	Lansing	Ingham
Mount Clemens general Hospital	Mt. Clemens	Macomb
Quest Diagnostics	Auburn Hills	Oakland
Regional Medical Laboratories	Battle Creek	Calhoun
Sparrow Regional Laboratories	Lansing	Ingham
Warde Medical Laboratories	Ann Arbor	Washtenaw

***OSHA approved blood lead laboratories as of May 13, 2009. for a complete listing of OSHA approved blood lead laboratories, visit the OSHA web site at http//www.osha.gov/SLTC/bloodlead/program.html**

All clinical laboratories conducting business in Michigan that analyze blood samples for lead must report all adult and child blood lead results to the Michigan Department of Community Health, Childhood Lead Poisoning Prevention Program (MDCH/CLPPP) within five working days.

MICHIGAN OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION REQUIREMENTS

Medical Monitoring and Medical Removal

The MIOSHA requirements for medical surveillance (i.e., biological monitoring) and medical removal are identical to those of Federal OSHA. The requirements for medical removal differ for general industry and construction. For general industry, an individual must have two consecutive BLLs above 60 µg/dL or an average of three BLLs greater than 50 µg/dL before being removed (i.e., taken pursuant to the standard or the average of all blood tests conducted over the previous six months, whichever is longer). For construction, an individual needs to have only two consecutive blood lead level measurements taken pursuant to the standard above 50 µg/dL. However, an employee shall not be required to be removed if the last blood-sampling test indicates a blood lead level ≤ 40 µg/dL. See Appendix C for a more detailed description of the requirements. It should be noted that in the absence of a specific exposure to lead, 95% of BLLs in the adult general population in the U.S. are below 5.3 µg/dL for men and below 3.6 µg/dL for women (1).

Dissemination of Surveillance Data

Biannual data summaries, without personal identifiers, are forwarded to the Program's funding agency, the National Institute for Occupational Safety and Health (NIOSH). NIOSH compiles reports from all states that require reporting of BLLs and publishes them in the Morbidity and Mortality Weekly Report (MMWR) (2). See Appendix A for the most recent publication of ABLES surveillance results for the period 2005 to 2007.

Results

2008 is the eleventh year with complete laboratory reporting in Michigan since the lead regulations became effective on October 11, 1997. Accordingly, this report provides a summary of all the reports of adult BLLs received in 2008 as well as more detailed information from interviews of those adults with BLL 25 µg/dL and greater and describes the 2008 Michigan Occupational Safety and Health Administration (MIOSHA) inspections at the work sites where these individuals were exposed to lead.

This report also provides information on a sample of individuals interviewed who had BLLs ranging from 10-24 µg/dL where the source of lead exposure was not identified in the original report submitted from the laboratories. Given the medical evidence of health effects at levels as low as 5 µg/dL (3-7), analysis of available information on BLL ranging from 5-9 µg/dL is also discussed in this report.

2008 is the eleventh year with complete laboratory reporting in Michigan since the lead regulations became effective on October 11, 1997.

Blood Lead Levels Reported in 2008

NUMBER OF REPORTS AND INDIVIDUALS

Between January 1 and December 31, 2008, the State of Michigan received 15,305 blood lead level reports for individuals 16 years of age or older. Because an individual may be tested more than once each year, the 15,305 reports received were for 13,682 individuals (Table 1). Up to 2008, the overall trend for the number of individuals tested each year has shown a gradual increase (Figure 1). The initial steeper increase in 1999 and 2000 probably was secondary to better compliance by the laboratories to the 1997 reporting regulation. The increase in more recent years is assumed secondary to increased testing while the drop in testing noted in 2008 is likely a reflection of the current Michigan economic downturn rather than reduced compliance with reporting by laboratories.

The following descriptive statistics are based on adults (≥ 16 years) tested in 2008. Where more than one BLL result was reported in 2008, statistics are based on the highest BLL reported for each individual.

DISTRIBUITON OF BLOOD LEAD LEVELS

In 2008, 688 (5.0%) of the 13,682 adults reported had BLLs ≥ 10 µg/dL; 129 of those 688 (18.8%) had BLLs ≥ 25 µg/dL and 7 of 129 (5.4%) had BLLs≥ 50 µg/dL (Table 1).

A total of 11,997 (87.6%) of adults reported in 2008 had BLL less than 5 µg/dL, and 997 (7.3%) were from individuals whose blood lead was 5 µg/dL – 9 µg/dL. Individuals with BLL 5 – 9 µg/dL are not routinely contacted, and when the source of lead exposure was identified, 149 of 997 (15%) individuals were identified as occupationally exposed. One hundred and eight (72%) of the 149 had been tested in previous years and 74 (68%) showed a marked decrease in their BLL.

Among the 559 individuals whose blood lead was 10 µg/dL – 24 µg/dL, 435 (77.8%) individuals had their source of lead exposure identified as occupational as compared to the 129 individuals with BLLs ≥ 25µg/dL where 87 (67.4%) individuals identified their source of lead exposure as occupational. There were 2 individuals with blood leads ≥ 25 µg/dL whose source of exposure still needs to be determined.

There was a marked decline in the overall number of individuals with elevated blood lead from occupational exposure from 2000-2005 with a plateau developing from 2006 - 2008 (Figure 2). For non-work exposures, elevated blood lead increased from 1998 until 2003, decreased until 2006 then increased in 2007 and 2008. (Figure 3).

Table 1 Distribution of Highest Blood Lead Levels (BLL) Among Adults and Source of Exposure in Michigan : 2008

BLLs (ug/dL)	Work BLL		Non-work BLL		Source Not Yet Identified		All BLL		
	Number	Percent	Number	Percent	Number	Percent	Number		Percent
<5	120	*	18	*	11,859	*	11,997		87.7
5-9	150	*	18	*	829	*	997		7.3
10-24	435	54.9	82	51.9	42	0.3	559		4.1
25-29	44	5.6	11	6.9	2	0.0	57		0.4
30-39	30	3.8	20	12.6	0	0.0	50		0.4
40-49	10	1.3	5	3.2	0	0.0	15		0.1
50-59	1	0.1	3	1.9	0	0.0	4		.03
≥ 60	2	0.3	1	.07	0	0.0	3		.02
TOTAL	**792**	**83.4++**	**158**	**16.6++**	**12,732**		**13,682**	**	**100.0**
TOTAL≥ 10 µg/dL	**522**	**81.1*** **	**122**	**18.9*** **	**44**		**688**		
TOTAL≥25 µg/dL	**87**	**68.5**** **	**40**	**31.5**** **	**2**		**129**		

*No follow-up is conducted of individuals with blood leads < 10 ug/dL, but often information is known

**In 2008, 15,305 BLL reports were received for 13,682 individuals. ++ percent of total known exposures (950)

*** percent of known exposures≥10 µg/dL(644) **** percent of known exposures ≥25 µg/dL (127)

In 2008, 688 (5.0%) of the 13,682 Michigan adults reported had BLLs ≥10 µg/dL;

129 of those 688 (18.8%) had BLLs ≥ 25 µg/dL

and 7 of 129 (5.4%) had BLLs ≥50 µg/dL.

Figure 2 **Number of Adults Reported with BLLs ≥10 µg/dL, ≥25 µg/dL and ≥50 µg/dL Exposed to Lead at WORK, Michigan 1998-2008**

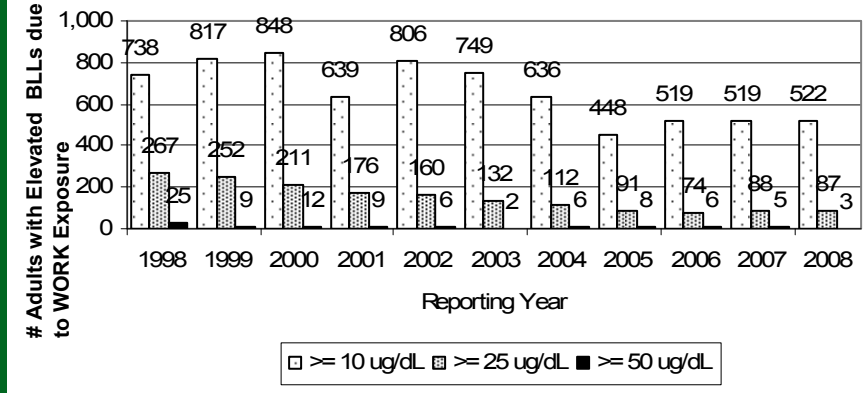


Figure 3 **Number of Adults Reported with BLLs ≥10 µg/dL, ≥25 µg/dL and ≥50 µg/dL Exposed to Lead NON-WORK, Michigan 1998-2008**

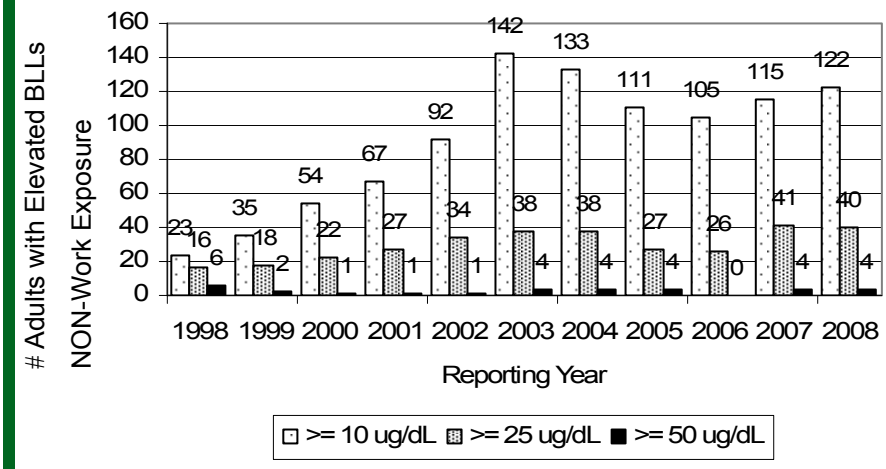


Table 3 Distribution of Age Among Adults Tested for Blood Lead in Michigan: 2008

	All Blood Lead Level Tests		Blood Lead Levels ≥ 10 µg/dL	
Age Range	Number	Percent	Number	Percent
16-19	1,161	8.5	8	1.2
20-29	2,440	17.8	113	16.4
30-39	2,465	18.0	135	19.6
40-49	2,734	20.0	171	24.9
50-59	2,520	18.4	172	25.0
60-69	1,275	9.3	68	9.9
70-79	628	4.6	16	2.3
80-89	411	3.0	4	0.6
90-99	42	0.3	1	0.1
100+	6	0.0	0	0.0
TOTAL	13,682	100.0	688	100.0

GENDER AND AGE DISTRIBUTION

All Blood Lead Levels

Fifty-eight percent of the adults reported to the Registry were male, and 42 percent were females (Table 2). The age distribution is shown in Table 3. The mean age was 42.7.

BLLs ≥ 10 µg/dL

For the 688 adults reported to the Registry with BLLs ≥ 10 µg/dL, 661 (96.1%) were men and 27 (3.9%) were women (Table 2). The age distribution for these adults is shown in Table 3. The mean age was 44.

There was a marked decline in the overall number of individuals with elevated blood lead from occupational exposure from 2000-2005 with a plateau developing from 2006 - 2008 .

Table 2 Distribution of Gender Among Adults Tested for Blood Lead in Michigan: 2008

	All Blood Lead Level Tests			Blood Lead Levels ≥ 10 µg/dL			Blood Lead Levels ≥ 25 µg/dL		
Gender	Number		Percent	Number		Percent	Number		Percent
Male	7,936		58.1	661		96.1	124		96.1
Female	5,727		41.9	27		3.9	5		3.9
Total	13,663	*	100.0	688		100.0	129		100

*Gender was unknown for 19 additional individuals.

Table 4 Distribution of Race Among Adults Tested for Blood Lead in Michigan: 2008

	Blood Lead Levels						
	All Results				Results ≥ 10 µg/dL		
Race	Number		Percent		Number		Percent
Caucasian	4,410		85.9		433		89.1
African American	576		11.2		34		7.0
Native American	54		1.1		5		1.0
Asian/Pacific Islander	61		1.2		2		0.4
Multiracial/Other	30		0.6		12		2.5
TOTAL	**5,131**	*	**100.0**		**486**	**	**100.0**

*Race was unknown for 8,551 additional individuals.

**Race was unknown for 202 additional individuals.

RACE DISTRIBUTION

All Blood Lead Levels

Although laboratories are required to report the patients' race, this information is frequently not provided. Race was missing for 8,551 (62.5%) of the 13,682 adults reported. Where race was known, 4,410 (85.9%) were reported as Caucasian, 576 (11.2%) were reported as African American, 61 (1.2%) were reported as Asian/ Pacific Islander, 54 (1.1%) were reported as Native American, and 30 (0.6%) were reported as Multiracial/ Other (Table 4).

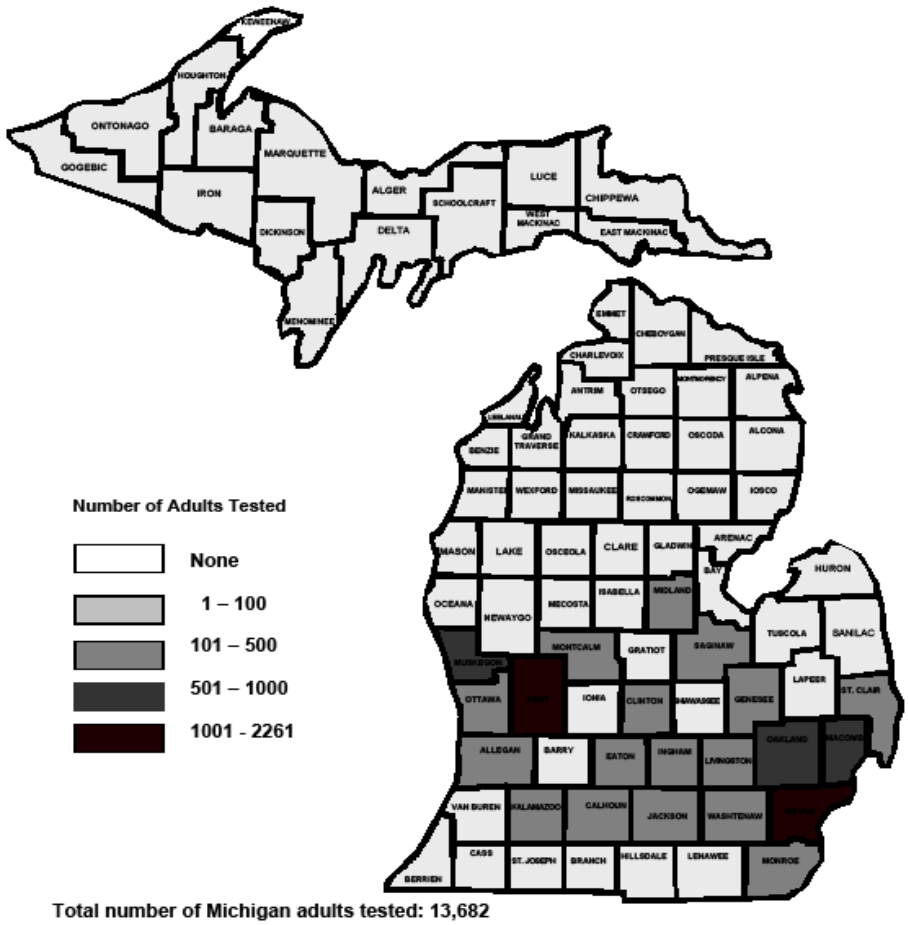
BLLs ≥ 10 µg/dL

For adults with BLLs greater than or equal to 10 µg/dL where race was indicated, 433 (89.1%) were reported as Caucasian, 34 (7.0%) were reported as African American, 12 (2.5%) were reported as Multiracial/Other, 5 (1.0%) were reported as Native American, and 2 (0.4%) were reported as Asian/ Pacific Islander, (Table 4).

GEOGRAPHIC DISTRIBUTION

County of residence was determined for 10,955 of the 13,682 adults reported to the Registry. They lived in 82 of Michigan's 83 counties. The largest number of adults reported in 2008 lived in Wayne County (2,261, 20.6%), followed by Kent County (1,278, 11.7%) and Oakland County (831, 7.6%). The county was unknown for 2,727 adults (Figure 4 and Table 5).

Figure 4 **Distribution of Adults Tested for Blood Lead in Michigan by County of Residence, 2008**



Total number of Michigan adults tested: 13,682
Total number with known counties: 10,955
County was unknown for 2,727 additional adults

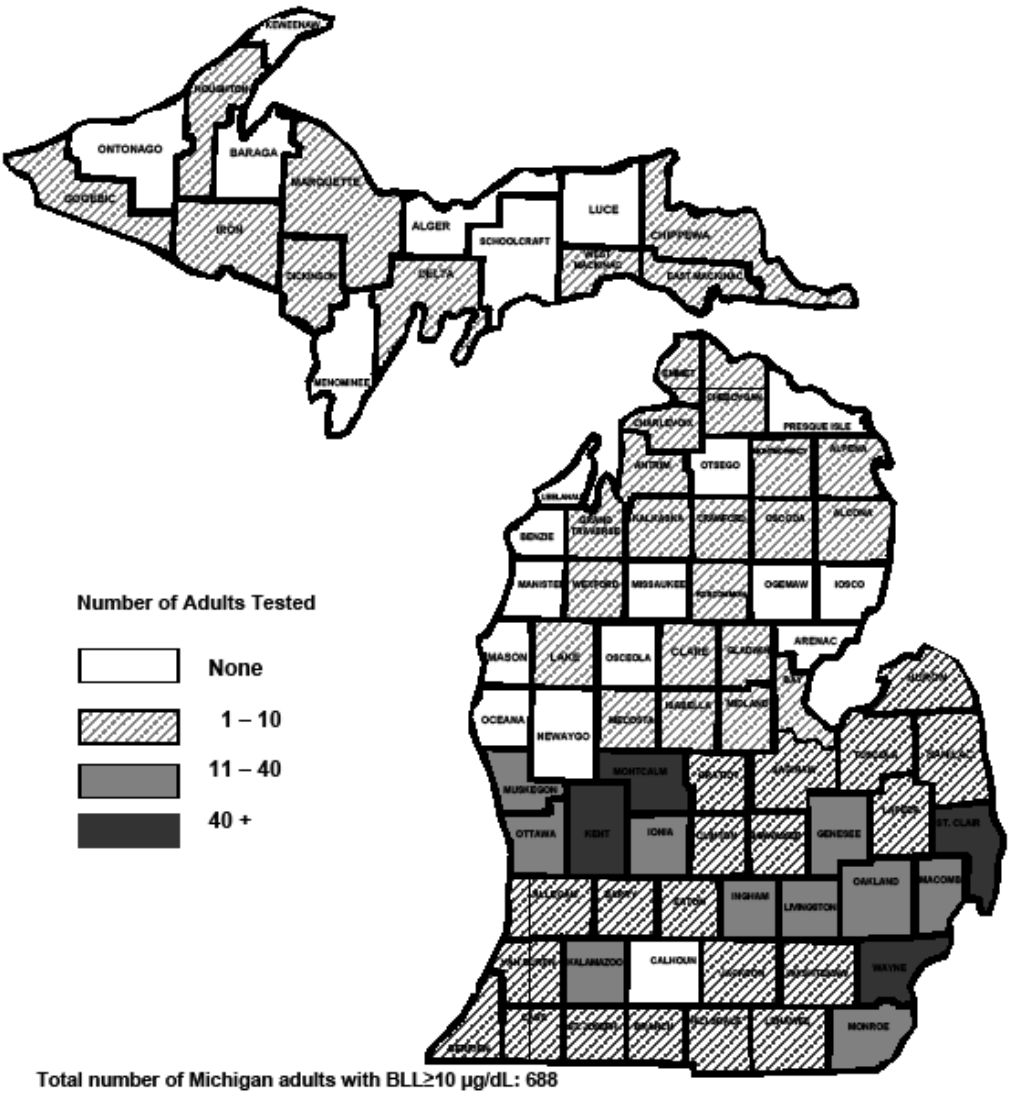
Wayne and Kent had the highest adults tested with 2,261 and 1,278 respectively.

Figure 5 and Table 5 show the county of residence of the 661 adults with BLLs greater than or equal to 10 µg/dL where county of residence could be determined. The largest number of adults reported with a BLL of 10 µg/dL and greater were from Wayne County (133, 20.1%), followed by Montcalm County (73, 11.0%) and St. Clair County (69, 10.4%). The county was unknown for 27 adults.

(Continued on page 12)

The largest number of adults reported in 2008 lived in Wayne County (2,261, 20.6%), followed by Kent County (1,278, 11.7%) and Oakland County (831, 7.6%).

Figure 5 **Distribution of Adults Tested WITH Blood Lead Levels ≥ 10 ug/dL in Michigan by County of Residence, 2008**



Total number of Michigan adults with BLL≥10 µg/dL: 688
Total number with BLL≥10 µg/dL and known counties: 661
County was unknown for 27 additional adults with BLL≥10 µg/dL

Wayne, Montcalm, StClair and Kent had the highest adults tested with 133, 73, 69 and 40 respectively.

TABLE 5 Number and Percent of Adults by County of Residence All BLLs, BLLs ≥ 10 ug/dL and BLLs ≥ 25 ug/dL and Percent of Adults with BLL ≥ 10 ug/dL and ≥ 25 ug/dL Among All Adults Tested 2008

	All BLLs		BLLs >10 ug/dL			BLLs >25 ug/dL		
County	Number	Percent of State Tests	Number	Percent of all BLLs in State	Percent of all BLLs in County	Number	Percent of all BLLs in State	Percent of all BLLs in County
Alcona	14	0.13	1	0.15	7.14	0	0.00	0.00
Alger	6	0.05	0	0.00	0.00	0	0.00	0.00
Allegan	104	0.95	2	0.30	1.92	0	0.00	0.00
Alpena	16	0.15	1	0.15	6.25	0	0.00	0.00
Antrim	16	0.15	1	0.15	6.25	0	0.00	0.00
Arenac	7	0.06	0	0.00	0.00	0	0.00	0.00
Baraga	13	0.12	0	0.00	0.00	0	0.00	0.00
Barry	57	0.52	1	0.15	1.75	0	0.00	0.00
Bay	89	0.81	2	0.30	2.25	0	0.00	0.00
Benzie	10	0.09	0	0.00	0.00	0	0.00	0.00
Berrien	79	0.72	9	1.36	11.39	2	1.57	2.53
Branch	19	0.17	2	0.30	10.53	0	0.00	0.00
Calhoun	163	1.49	0	0.00	0.00	0	0.00	0.00
Cass	17	0.16	1	0.15	5.88	0	0.00	0.00
Charlevoix	29	0.26	1	0.15	3.45	0	0.00	0.00
Cheboygan	29	0.26	1	0.15	3.45	0	0.00	0.00
Chippewa	48	0.44	4	0.61	8.33	1	0.79	2.08
Clare	30	0.27	1	0.15	3.33	0	0.00	0.00
Clinton	100	0.91	6	0.91	6.00	1	0.79	1.00
Crawford	59	0.54	1	0.15	1.69	0	0.00	0.00
Delta	21	0.19	2	0.30	9.52	1	0.79	4.76
Dickinson	14	0.13	1	0.15	7.14	0	0.00	0.00
Eaton	125	1.14	7	1.06	5.60	0	0.00	0.00
Emmet	27	0.25	2	0.30	7.41	0	0.00	0.00
Genesee	379	3.46	17	2.58	4.49	3	2.36	0.79
Gladwin	18	0.16	1	0.15	5.56	0	0.00	0.00
Gogebic	15	0.14	1	0.15	6.67	1	0.79	6.67
GrTraverse	84	0.77	7	1.06	8.33	1	0.79	1.19
Gratiot	81	0.74	6	0.91	7.41	2	1.57	2.47
Hillsdale	19	0.17	3	0.45	15.79	0	0.00	0.00
Houghton	26	0.24	2	0.30	7.69	1	0.79	3.85
Huron	26	0.24	6	0.91	23.08	1	0.79	3.85
Ingham	317	2.89	17	2.58	5.36	3	2.36	0.95
Ionia	81	0.74	27	4.09	33.33	1	0.79	1.23
Iosco	14	0.13	0	0.00	0.00	0	0.00	0.00
Iron	5	0.05	1	0.15	20.00	0	0.00	0.00
Isabella	65	0.59	2	0.30	3.08	0	0.00	0.00
Jackson	134	1.22	3	0.45	2.24	1	0.79	0.75
Kalamazoo	286	2.61	18	2.73	6.29	6	4.72	2.10
Kalkaska	10	0.09	0	0.00	0.00	0	0.00	0.00
Kent	1,278	11.67	40	6.06	3.13	7	5.51	0.55
Keweenaw	0	0.00	0	0.00	0.00	0	0.00	0.00
Lake	15	0.14	1	0.15	6.67	1	0.79	6.67
Lapeer	64	0.58	3	0.45	4.69	1	0.79	1.56

Continued

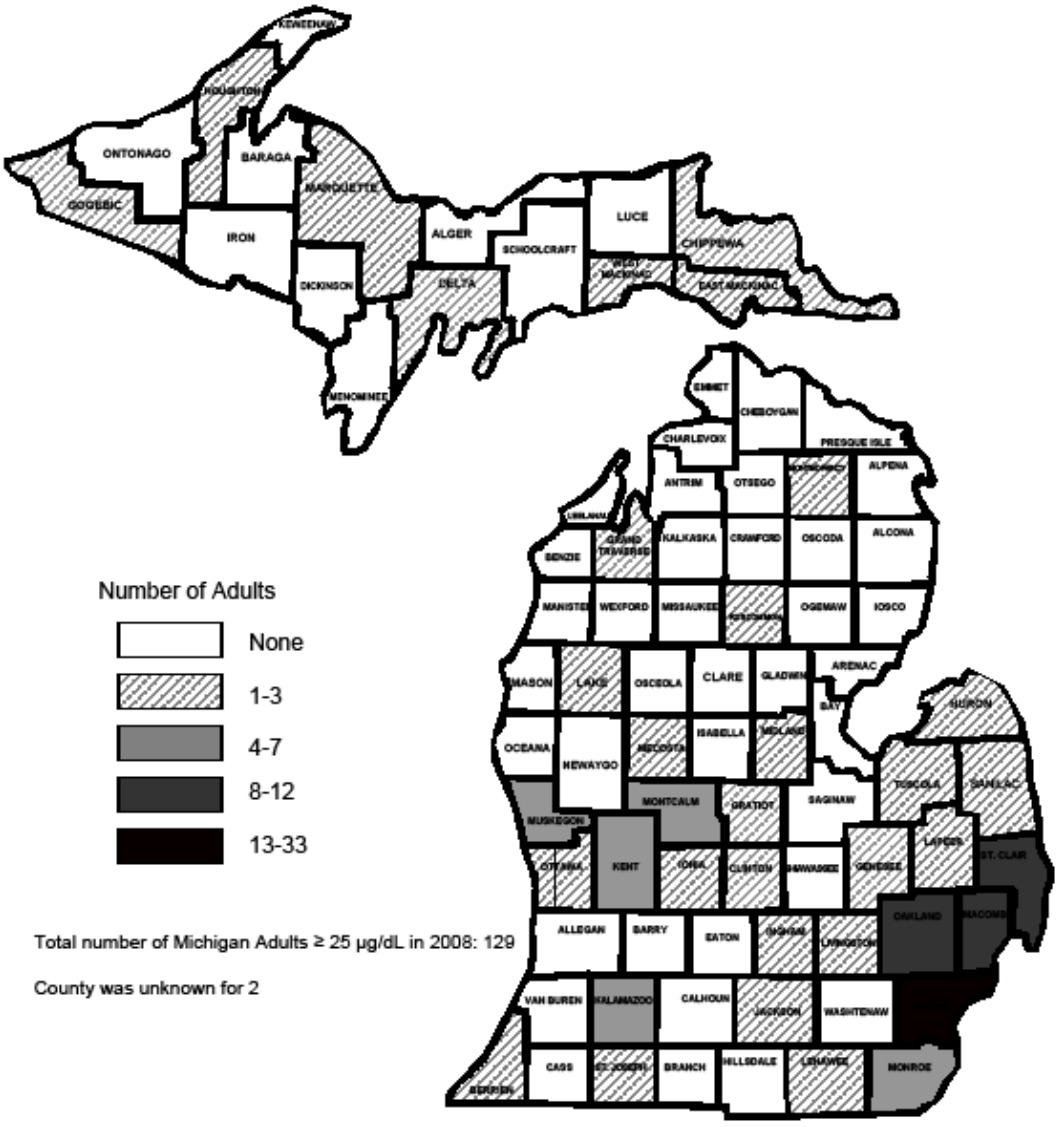
	All BLLs		BLLs >10 ug/dL			BLLs >25 ug/dL		
County	Number	Percent of State	Number	Percent of all BLLs in State	Percent of all BLLs in County	Number	Percent of all BLLs in State	Percent of all BLLs in County
Leelanau	8	0.07	0	0.00	0.00	0	0.00	0.00
Lenawee	85	0.78	5	0.76	5.88	2	1.57	2.35
Livingston	203	1.85	13	1.97	6.40	3	2.36	1.48
Luce	4	0.04	0	0.00	0.00	0	0.00	0.00
Mackinac	28	0.26	1	0.15	3.57	1	0.79	3.57
Macomb	763	6.97	37	5.61	4.85	10	7.87	1.31
Manistee	19	0.17	0	0.00	0.00	0	0.00	0.00
Marquette	43	0.39	4	0.61	9.30	1	0.79	2.33
Mason	14	0.13	0	0.00	0.00	0	0.00	0.00
Mecosta	31	0.28	4	0.61	12.90	1	0.79	3.23
Menominee	17	0.16	0	0.00	0.00	0	0.00	0.00
Midland	230	2.10	3	0.45	1.30	1	0.79	0.43
Missaukee	14	0.13	0	0.00	0.00	0	0.00	0.00
Monroe	305	2.78	20	3.03	6.56	5	3.94	1.64
Montcalm	178	1.62	73	11.06	41.01	7	5.51	3.93
Montmorency	10	0.09	3	0.45	30.00	2	1.57	20.00
Muskegon	548	5.00	15	2.27	2.74	4	3.15	0.73
Newaygo	23	0.21	0	0.00	0.00	0	0.00	0.00
Oakland	831	7.59	38	5.76	4.57	9	7.09	1.08
Oceana	25	0.23	0	0.00	0.00	0	0.00	0.00
Ogemaw	7	0.06	0	0.00	0.00	0	0.00	0.00
Ontonagon	11	0.10	0	0.00	0.00	0	0.00	0.00
Osceola	14	0.13	0	0.00	0.00	0	0.00	0.00
Oscoda	12	0.11	1	0.15	8.33	0	0.00	0.00
Otsego	13	0.12	0	0.00	0.00	0	0.00	0.00
Ottawa	113	1.03	11	1.67	9.73	2	1.57	1.77
Presque Isle	12	0.11	0	0.00	0.00	0	0.00	0.00
Roscommon	44	0.40	1	0.15	2.27	1	0.79	2.27
Saginaw	133	1.21	7	1.06	5.26	0	0.00	0.00
Saint Clair	252	2.30	69	10.45	27.38	8	6.30	3.17
Saint Joseph	27	0.25	2	0.30	7.41	1	0.79	3.70
Sanilac	64	0.58	5	0.76	7.81	1	0.79	1.56
Schoolcraft	6	0.05	0	0.00	0.00	0	0.00	0.00
Shiawassee	92	0.84	3	0.45	3.26	0	0.00	0.00
Tuscola	35	0.32	2	0.30	5.71	1	0.79	2.86
Van Buren	89	0.81	4	0.61	4.49	0	0.00	0.00
Washtenaw	359	3.28	5	0.76	1.39	0	0.00	0.00
Wayne	2,261	20.63	133	20.00	5.84	33	25.98	1.46
Wexford	23	0.21	1	0.15	4.35	0	0.00	0.00
TOTAL	**10,955**	100.0*	**661**	100.0**	6.03	**127**	100.***	1.16

*County was unknown for 2,727 additional adults.

**County was unknown for 27 additional adults.

***County was unknown for 2 additional adults.

Figure 6 **Distribution of Adults with Blood Lead Levels ≥25 µg/dL in Michigan by County of Residence, 2008**



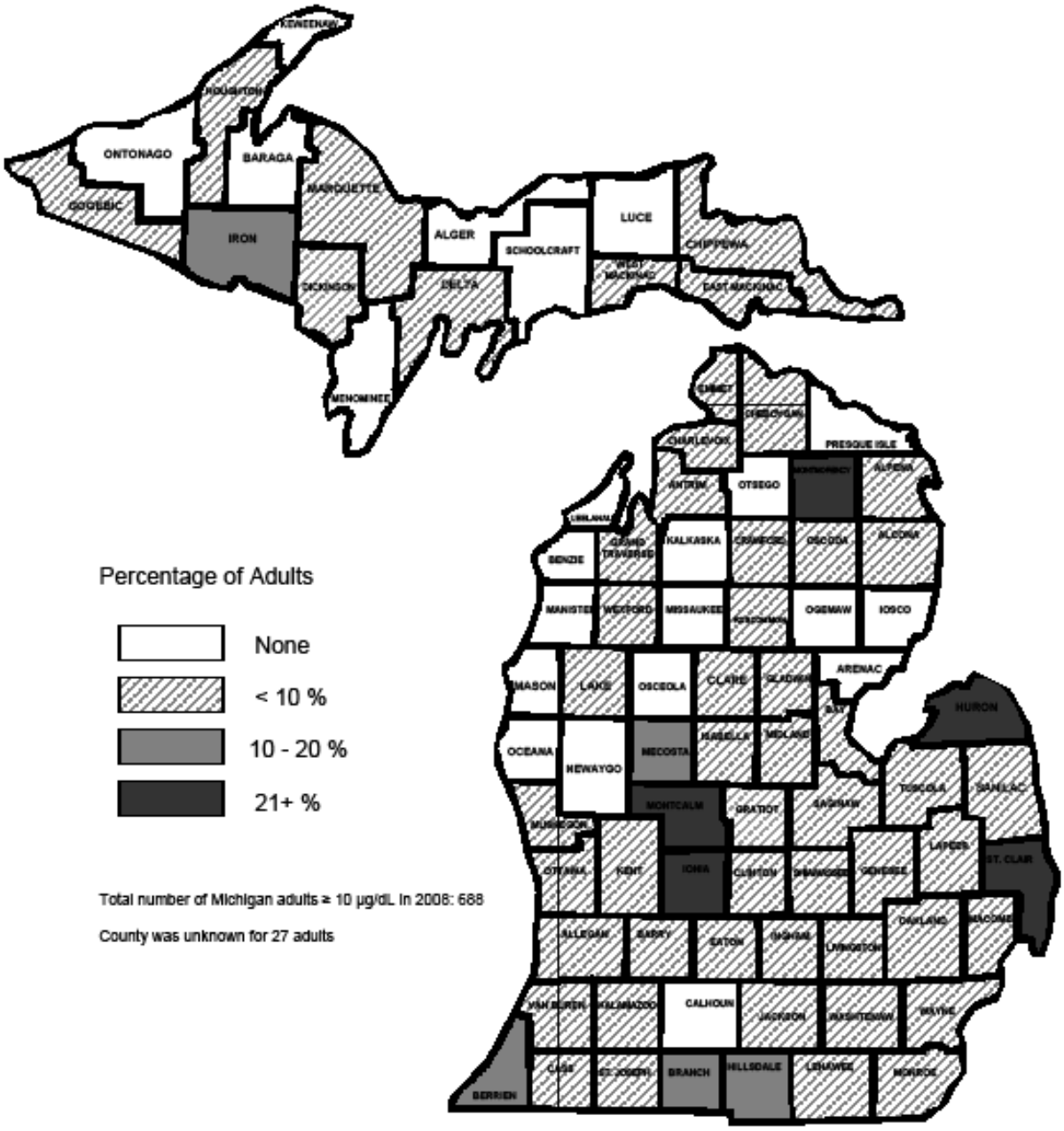
(Continued from page 9)

Figure 6 and Table 5 show the county of residence for the 127 adults with BLLs ≥ 25 µg/dL where county of residence could be determined. The largest number of adults reported with a BLL of 25 µg/dL and above were from Wayne County (33, 25.9%), followed by Macomb County (10, 7.8%). The county was unknown for two adults.

Figure 7 and Table 5 show the percentage of adults, within each county, tested for blood lead with BLLs ≥10 µg/dL. Montcalm (80, 46.8%), St. Clair (70, 28.0%), and Kalkaska (20, 18.2%) counties had the highest percentages of adults with BLL ≥10 µg/dL within their respective counties.

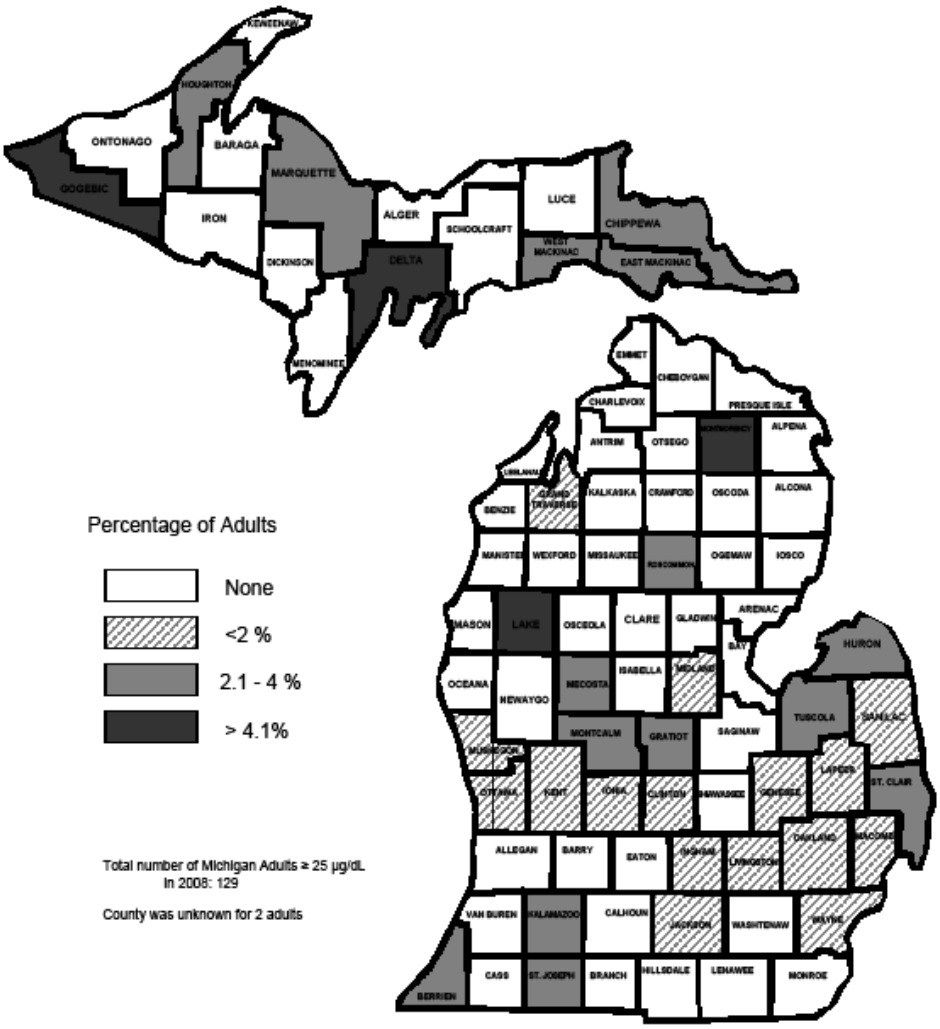
County of residence was determined for 10,955 of the 13,682 adults reported to the Registry. They lived in 82 of Michigan's 83 counties.

Figure 7 **Percentage of Blood Lead Levels ≥ 10 µg/dL within each County of Residence for Adults in Michigan, 2008***



* Denominator used was the total number of adults tested for blood lead within each county

Figure 8 **Percentage of Adults all Blood Lead Levels ≥ 25 µg/dL in Michigan by County of Residence, 2008***



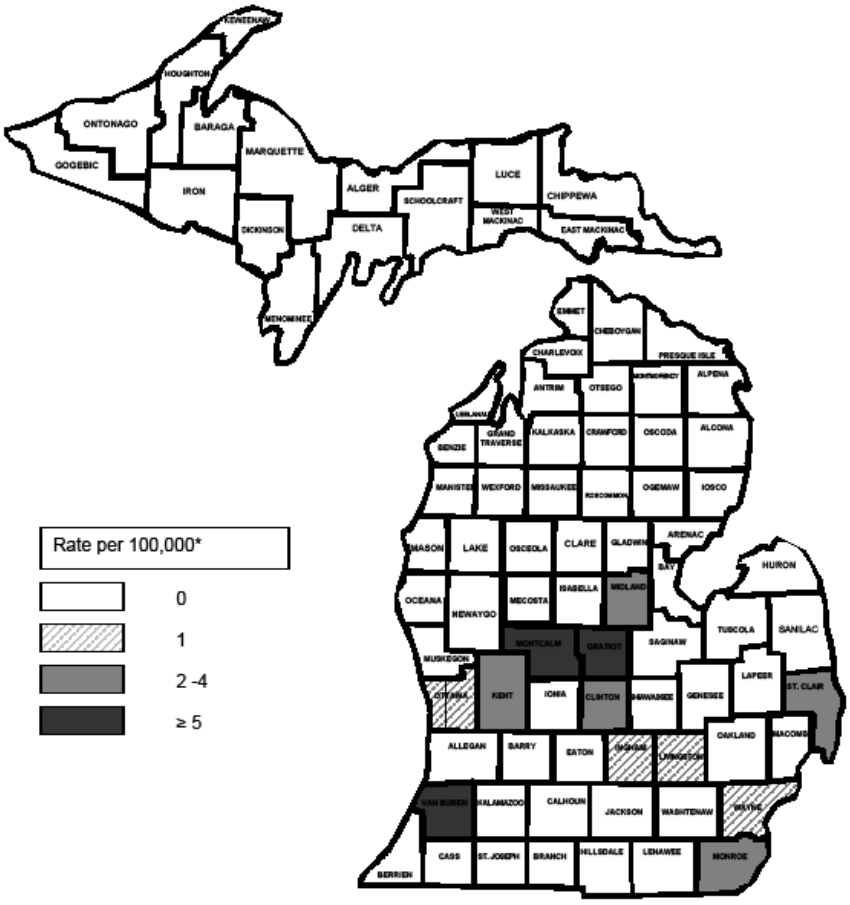
* Denominator used was the total number of adults tested for blood lead within each county

Figure 8 and Table 5 show the counties with the highest percentage of test results where BLL was equal or greater than 25 µg/dL, within each county. Montmorency (2, 20.0%), Lake (1, 6.7%) and Montcalm (7, 3.9%) counties had the highest percentages of BLLs tests ≥ 25 µg/dL.

GENDER DISTRIBUTION

Figure 9 and Table 6 show the incidence rates of BLL of 10 µg/dL and above, by county, for women. There were 27 women reported in 2008 with a BLL of 10 µg/dL or greater. Montcalm (8/100,000) and Gratiot and VanBuren (6/100,000 each) had the three highest incidence rates. Nine women (52.9%) with elevated blood lead had their exposure from work: two from stained glass, two from metal forging and stampings, two from electric supply, one from extruding non-ferrous metal, one from painting and paperhanging, one unknown employer, presumed work from lab information. Women with elevated blood leads also had non-work exposures from: remodeling performed in their homes (3, 11.7%), firearms (2, 11.7%), hobbies (1, 5.9%), one case of pica, one of a gun shot wound, one with unknown source was an immigrant, and one was determined to be a lab error. Source of exposure was unknown for eight of the 27 women.

Figure 9 **Annual Incidence of Blood Lead Levels ≥10 µg/dL Among Women in Michigan by County of Residence, 2008***



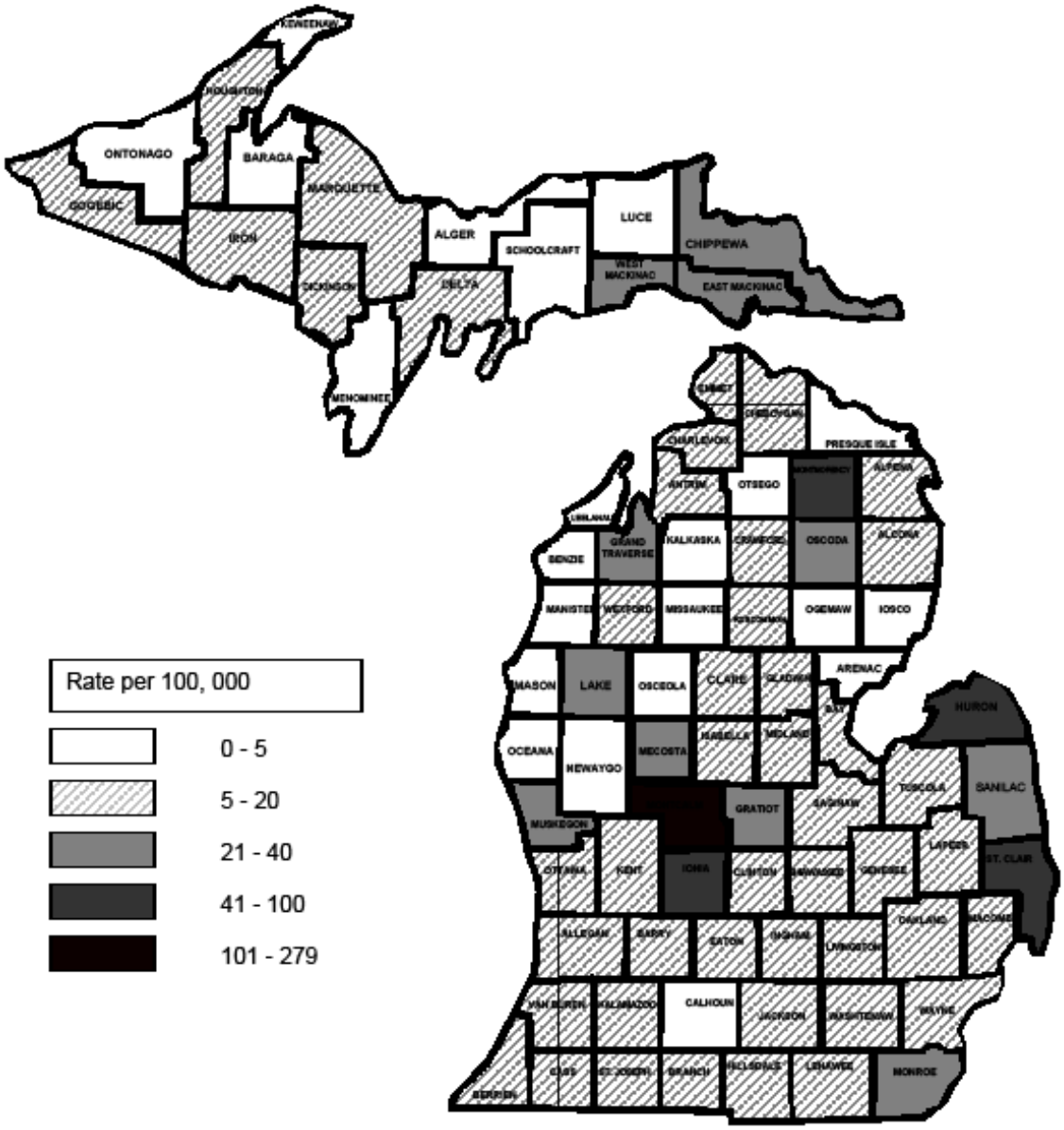
Denominator is Rate per 100,000 women age 16+ from Census County Population Estimates Apri1, 200 to July 1, 2007

Table 6 County of Residence Among Women w/ BLL > 10 µg/dL in Michigan: 2008

County	Number Reported	Michigan Population Women		Rate per 100,000 Women	
Clinton	1	27,785		4	
Gratiot	1	15,960		6	
Ingham	1	117,007		1	
Kent	5	234,040		2	
Livingston	1	71,956		1	
Midland	1	33,746		3	
Monroe	1	61,783		2	
Montcalm	2	24,181		8	
Oakland	1	488,956		0	
Ottawa	1	102,415		1	
St Clair	3	68,622		4	
VanBuren	2	30,938		6	
Wayne	7	802,333		1	
TOTAL	**27**	**4,069,224**	**	1	***

**Total number of women in all 83 counties of Michigan age 16+ years; 7/1/2007 County Characteristics Resident Population Estimates, U.S. Census Bureau
***Rate per 100,000 women, age 16+ years.

Figure 10 **Annual Incidence of Blood Lead Levels ≥10 µg/dL Among Men in Michigan by County of Residence, 2008***



Denominator is Rate per 100,000 men age 16+ from Census County Population Estimates April1, 2000 to July 1, 2007

Figure 10 and Table 7 show the incidence rates of BLL of 10 µg/dL and above by county, for men. There were 634 men reported in 2008 with a BLL of 10 µg/dL or greater where county of residence could be determined. Montcalm (279/100,000), St. Clair (100/100,000) and Ionia, (97/100,000) had the highest incidence rates. The overall incidence rate for men was 16 times higher than that for women (16/100,000 vs. 1/100,000).

In Michigan the overall incidence rate of BLLs ≥ 10 µg/dL was 16 times higher for men than for women.

Table 7 County of Residence Among Men w/ BLL ≥ 10 ug/dL in Michigan: 2008

County	Number Reported	Michigan Population Men	Rate per 100,000 Men	County	Number Reported	Michigan Population Men	Rate per 100,000 Men
Alcona	1	4,954	20	Keweenaw	0	933	0
Alger	0	4,438	0	Lake	1	4,616	22
Allegan	2	43,399	5	Lapeer	3	37,063	8
Alpena	1	11,908	8	Leelanau	0	9,100	0
Antrim	1	9,803	10	Lenawee	5	40,235	12
Arenac	0	7,019	0	Livingston	12	71,946	17
Baraga	0	3,930	0	Luce	0	3,274	0
Barry	1	23,318	4	Mackinac	1	4,537	22
Bay	2	41,597	5	Macomb	37	320,820	12
Benzie	0	6,918	0	Manistee	0	10,487	0
Berrien	9	59,784	15	Marquette	4	27,461	15
Branch	2	18,811	11	Mason	0	11,352	0
Calhoun	0	51,536	0	Mecosta	4	17,510	23
Cass	1	20,202	5	Menominee	0	9,813	0
Charlevoix	1	10,328	10	Midland	2	32,112	6
Cheboygan	1	10,730	9	Missaukee	0	5,875	0
Chippewa	4	18,837	21	Monroe	19	59,959	32
Clare	1	12,071	8	Montcalm	71	25,480	279
Clinton	5	27,039	18	Montmorency	3	4,243	71
Crawford	1	6,187	16	Muskegon	15	66,988	22
Delta	2	14,986	13	Newaygo	0	18,958	0
Dickinson	1	10,589	9	Oakland	37	464,248	8
Eaton	7	41,641	17	Oceana	0	10,772	0
Emmet	2	13,030	15	Ogemaw	0	8,663	0
Genesee	17	158,876	11	Ontonagon	0	3,068	0
Gladwin	1	10,524	10	Osceola	0	9,002	0
Gogebic	1	7,362	14	Oscoda	1	3,578	28
Grand Traverse	7	33,889	21	Otsego	0	9,532	0
Gratiot	5	18,309	27	Ottawa	10	97,284	10
Hillsdale	3	18,402	16	Presque Isle	0	5,753	0
Houghton	2	15,909	13	Roscommon	1	10,423	10
Huron	6	13,539	44	Saginaw	7	75,411	9
Ingham	16	107,476	15	Saint Clair	66	66,138	100
Ionia	27	27,817	97	Saint Joseph	2	23,645	8
Iosco	0	10,627	0	Sanilac	5	16,979	29
Iron	1	5,169	19	Schoolcraft	0	3,564	0
Isabella	2	26,331	8	Shiawassee	3	27,642	11
Jackson	3	66,057	5	Tuscola	2	22,443	9
Kalamazoo	18	93,824	19	Van Buren	2	29,745	7
Kalkaska	0	6,723	0	Washtenaw	5	140,980	4
Kent	35	225,013	16	Wayne	126	722,722	17
				Wexford	1	12,352	8
				TOTAL	**634** *	**3,865,608** **	**16** ***

*County was unknown for 27 additional male adults. **Total number of men in all 83 counties of Michigan age 16+ years; 7/1/2007 County Characteristics Resident Population Estimates, U.S. Census Bureau ***Rate per 100,000 men, age 16+ years.

Table 8 Source of Exposure Among Adults with BLL ≥ 10 µg/dL

Exposure Source Description	Number	Percent
Work-Related	522	83.3
Hobby: Firearms, Reloading, Casting	77	12.3
Remodeling	9	1.4
Gun Shot Wound	6	1.0
Hobby: Leather Tooling (1), Race Cars, unidentified	4	0.6
Other, Non-work	4	0.6
Lab Error	2	0.3
Hobby: Stained Glass	1	0.2
Hobby: Sinkers	1	0.2
Lead Paint Ingestion	1	0.2
TOTAL	**627**	* **100.0**

*For 28 additional adults source is pending an interview; for 15 additional adults source is pending medical records review; for 10 additional adults source was inconclusive based on interview; for 8 additional adults, source was inconclusive and no patient interview was attempted.

SOURCE OF EXPOSURE

Table 8 shows the source of exposure of lead for individuals with BLLs greater than 10 µg/dL reported in 2008. For 522 (83.3%) individuals, work was the identified source. For 105 (16.7%) additional individuals non-occupational activities were identified as the source of exposure. Of those 105, two non-occupational activities predominated. 77 (73.3%) individuals were exposed from a hobby related to guns and nine (8.6%) were exposed during home remodeling. For an additional 43 individuals, source of exposure is still being investigated. For 18, source was still unknown after an interview with the individual and review of medical records.

Table 9 shows the occupational sources of lead for individuals reported in 2008. The most frequent reports were on individuals in the manufacturing sector (46.4%), and construction (30.7%).

Table 9 Industry Exposure of Individuals with BLL ≥ 10 µg/dL

Industry (SIC Code)*	Number	Percent
Construction (15-17)	**153**	**30.7**
Painting (17)	133	26.7
Manufacturing (20-39)	**231**	**46.4**
Fabricated and Primary Metals (33-34)	213	42.8
Transportation and Public Utilities (40-49)	**43**	**8.6**
Wholesale and Retail Trade (50-59)	**16**	**3.2**
Services (60-89)	**41**	**8.2**
Automotive Repair Services (75)	6	1.2
Public Administration (91-97)	**14**	**2.8**
Justice, Public Order, Safety (92)	10	2.0
TOTAL	498	100.0

*Standard Industrial Classification. **Another 24 were work-related, however, the industry was unknown.

Figure 11 shows the geographic distribution of the seventeen non-construction companies that reported at least one adult with a BLL of 25 µg/dL or greater in Michigan during 2008. For six additional companies we were unable to determine county. These twenty-three companies included reclamation operations, metal forging and stamping companies, brass/bronze casting operations, coating and engraving operations, radiator repair facilities and indoor firing ranges. Of the 522 individuals with blood lead ≥ 10 µg/dL where exposure occurred at work, 260 (49.8%) were from these twenty-three companies. Of the 87 individuals with blood lead ≥ 25µg/dL and exposure occurred at work, 54 (62.1%) were also from these twenty-three companies.

Figure 11 Geographic Distribution of Non-Construction Companies Reporting Adult Blood Lead Levels (BLL) ≥ 25 µg/dL in Michigan, 2008

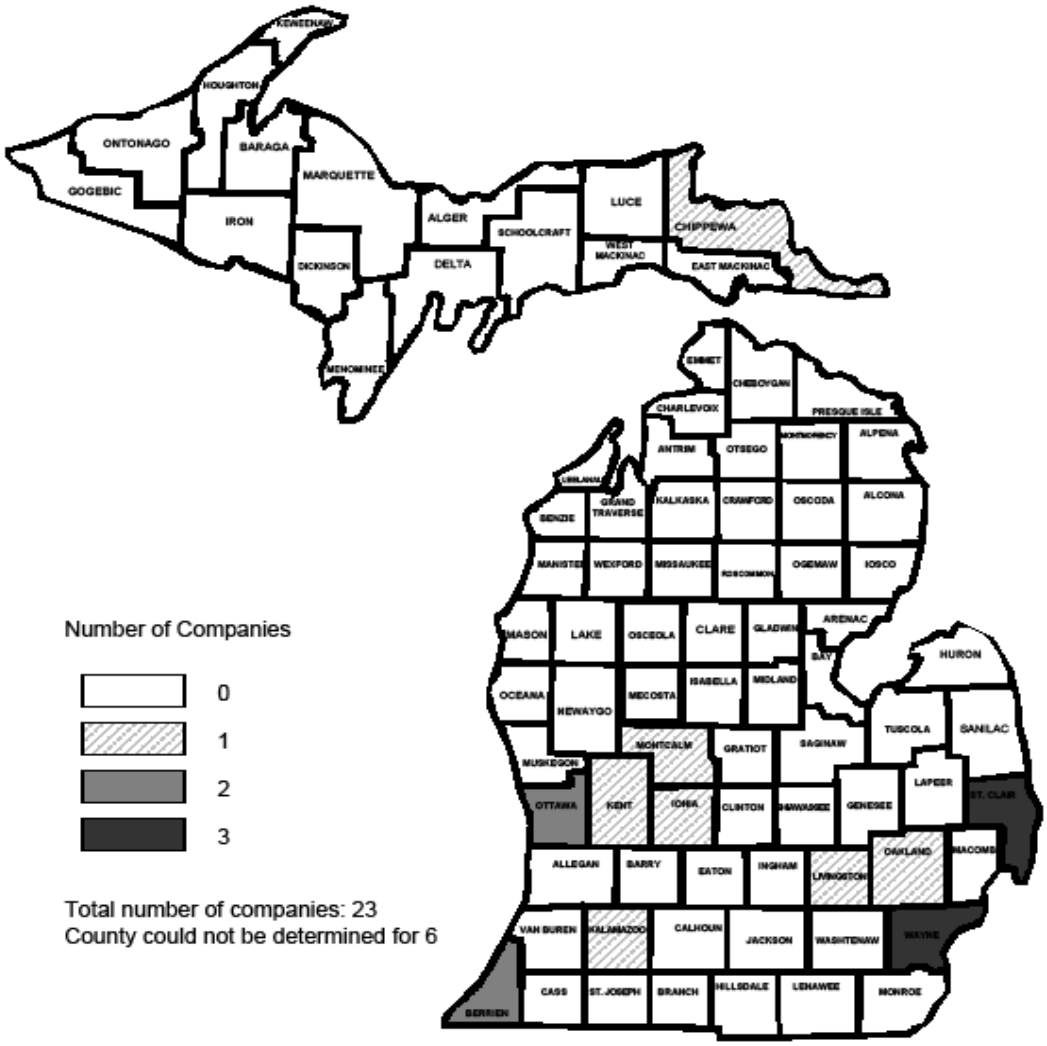
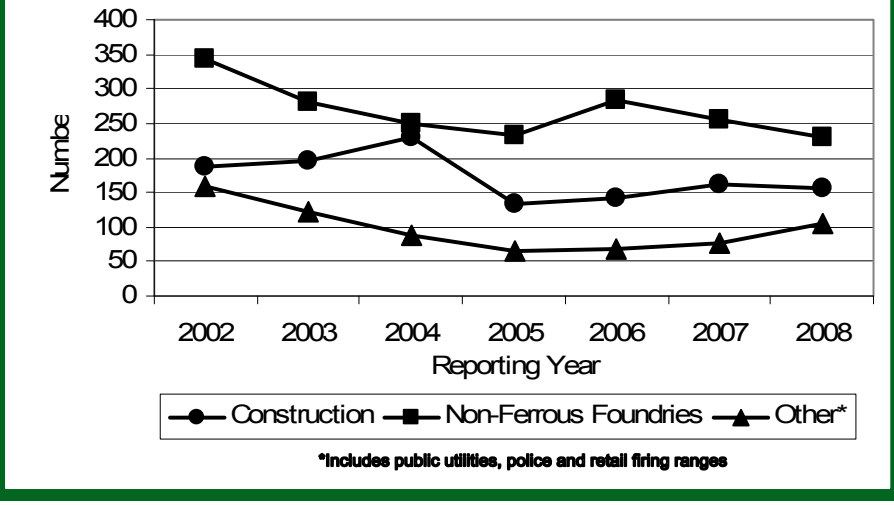


Figure 12 Number of Individuals with BLLs ≥ 10µg/dL by Industry Where Exposed to Lead in Michigan, 2002—2008



Although BLLs have generally been decreasing across all types of occupational sources, a slight increase in percentage of lead has been reported from exposure categorized as "Other" since 2006 (Figure 12). This category includes public utilities, police and public firing ranges.

SUMMARY OF - INDUSTRIAL HYGIENE INSPECTIONS

Since the 2007 report, the statewide surveillance system identified 14 companies where MIOSHA had not performed a recent inspection for lead. Ten of those companies were inspected as well as three companies referred in 2007.

The first company inspected was based on a lab report in 2006 of an employee with an elevated blood lead level of 148 µg/dL. This company's primary work was an automated e-coating process for automotive parts. In review of material safety data sheets and discussion with the paint supplier, it was determined the paint medium used did not contain lead. Air samples and wipe samples demonstrated lead at a level below the MIOSHA Lead Standard. A citation was issued for lack of a written hazard communication program and violation of the respiratory protection standard. The source of lead presumably did not occur at this company.

The second company inspected was at an automobile parts retail repair shop in west Michigan where radiators are rebuilt. Of the fifteen citations issued by MIOSHA, fourteen were lead related. Exposure monitoring and respiratory protection violations, protective work clothing and equipment violations, hygiene facility violations, posting and monitoring of lead areas and training violations were all issued to the company.

Another referral of a radiator shop in Michigan resulted in no MIOSHA citations for lead or other health regulations. Lead was identified in the workplace but at exposure levels below MIOSHA limits.

Two construction companies were inspected. At the time of inspection no lead removal activities were being performed. The elevated BLLs recorded by one company were within MIOSHA lead exposure construction standards and no citations were issued. The other construction company was inspected based on an employee who tested five different times during 2008 with levels greater than 25 µg/dL, and a maximum blood lead level of 77 µg/dL. Exposure to lead was suspected to be from abrasive blasting of a covered bridge in southwest Michigan. Because the construction activity had been completed by the time of the inspection, lead exposure could not be assessed and no lead violations were issued. However silica was being used as the abrasive blasting media and the company was cited for a violation of the Hazard Communication Standard. In addition the company was cited for two other safety violations.

A hazardous waste treatment disposal company was inspected because of a blood lead level reported at 87 µg/dL in late 2007. It was determined that employees were exposed to lead levels of 7,900 $\mu g/m^3$, in excess of 150 times the permissible exposure limit (PEL). The employer did not conduct representative air monitoring nor did they provide appropriate respiratory equipment. Appropriate follow-up blood sampling for employees exceeding the numerical criterion for the medical removal standard was also not provided. Five lead related citations were issued as well as two additional citations for not providing personal protective equipment, and not recording and reporting occupational injuries and illnesses.

Two manufacturing companies were inspected. One company had documented the use of lead in several processes, had written lead control policies and had control measures in place that set removal levels below the MIOSHA blood lead removal limit. The MIOSHA inspection documented that controls were in place and that exposures were below the action levels for both lead and copper. The company was cited for a violation of an eye wash station within the work area.

The other manufacturing company was inspected based on a private provider report of an employee lead level of 24 µg/dL. This company machined a metal alloy containing 2.5% lead, ac-

cording to the per material safety data sheet. Air monitoring demonstrated lead within the MIOSHA limits, but wipe samples showed the presence of lead on the palms of some employees and in analyzed bulk samples from various stations of the manufacturing process. The company was cited for not conducting exposure monitoring for lead and not training employees on the possible health effects of lead exposure.

A printed circuit assembly company was inspected based on an employee with a blood lead level of 43 µg/dL. Personal air sampling was conducted and no detectable level of lead was found. No violations were determined.

A marine repair company was inspected based on the report of an employee with a blood lead level of 50 µg/dL. The company was involved in barge refurbishing and because of its location on the Great Lake Waterways, it fell under federal jurisdiction. Federal OSHA inspected this facility. Torch cutting of metal covered with lead paint, without the use of appropriate respiratory protection, was the source of lead exposure.

A fabrication shop went out of business before an inspection could be completed based on a referral due to an elevated blood lead level of 28 µg/dL. Initial review of material safety data sheets, as well as actual materials, did not show presence of lead at this site. However, employees did conduct off site repair as part of their employment. No violations were determined.

A scrap metal recycler was inspected based on a referral from an elevated blood lead level of 28µg/dL. It was determined that employees were given official leave and allowed to work for a demolition company during their employment with this recycler. A MIOSHA inspection at the site included air monitoring and wipe sampling. The presence of lead was demonstrated on surfaces in the workspace and break room as well as on the inside of a respirator used by one of the workers. This company received four lead-related citations and one respiratory protection violation and an additional referral was made to review project records of the demolition company.

Two firearm shooting ranges were referred for inspection in 2008. One referral was made for a sports firearm shooting range. One employee was evaluated for lead exposure while sweeping the shooting range. It was determined that lead exposure levels were below MIOSHA limits. The Hazard Communication Standard for posting and written communication was not met by this facility and one citation for that was issued. The other range referred had several locations throughout the state. The location referred was not inspected but an alternate site was cited for two lead violations for lack of monitoring and hazard communication.

Lead exposure at firearm target ranges where there are no employees, only club members, are outside of MIOSHA jurisdiction. A complaint referencing four reports of high levels of lead ranging from 17 to 79 µg/dL was received from such a gun club in 2008. Concern for potential take-home exposures to families was not enough to convince State or local health departments to address this issue and there were no employees. MIOSHA could not intervene.

Of the fourteen companies inspected in 2008, eight were identified by an elevated blood lead report collected because of the company's medical surveillance program, four were reported from private providers and two reports had undetermined sources.

When an individual from a company is identified with a blood lead value of 25 µg/dL or greater, a MIOSHA enforcement inspection is conducted to assess that company's compliance with the lead standard.

Case Narratives

Seven Individuals with a BLL ≥ 50 µg/dL in 2008

Work-Related (3)

Construction, Bridge Tunnel and Elevated Highway (SIC 1622) (1)

A male in his 40s had blood lead testing as part of his company medical screening program. His BLLs in 2008 ranged from 53 to 77 µg/dL. He reported no symptoms and denied any lead-related hobbies. He had worked eighteen years for the same construction firm with no previous blood lead testing. As part of his job he drilled holes on structural steel coated with lead based paint and wore a respirator for 10 hours a day.

Special Trades Contractor (SIC 1799) (1)

A male in his 30s had blood lead testing by his private physician after completing a remodeling job "on the side." His physician reported exposure to paint. His lead level ranged from 66 µg/dL at initial testing to 77 µg/dL one month later and two months later BLLs dropped to 13 µg/dL. This individual declined an interview. No company was identified.

Ship Building and Repairing (SIC 3732) (1)

A male in his 50s had BLLs taken in 2008 starting at 50 µg/dL and dropping to 44 µg/dL after two subsequent tests. He was referred by a private physician who reported his employment involved demolition of Great Lakes barges. Attempts to contact this individual have been unsuccessful.

Non-Work Related (4)

Casting (1)

A male in his 60s requested blood lead testing from his personal physician. His BLLs in 2008 ranged from 39 to 76 µg/dL. He has had testing over the last five years with history of BLLs as low as 10 µg/dL. In a 2003 interview he denied any employment where he might have been exposed to lead and did not smoke cigarettes. He reported no symptoms but did indicate a loss in hearing. For the past forty years, on an intermittent basis, he reported that he had been involved in casting bullets but with additional medical information it was discovered that his source of exposure for 2008 was related to collecting spent shells from firing ranges and melting them down to make lead diving weights. When a re-interview was attempted, he refused, indicating he didn't intend to change any of his lead activities.

Gun Shot Wound (1)

A male in his 40s, whose case was discussed in the 2007 Annual Report, had complaints of stabbing, severe pain in his epigastric region and lower chest and associated encephalopathy. He had a past medical history of hypertension and IV drug use. He also had sustained a gunshot wound in his right leg 2 years ago that had been operated upon and an intra-medullary rod placed. He was found to have microcytic anemia that was associated with basophilic stippling. Testing in 2007 showed a BLL of 306 µg/dL. No history of exposure to lead at work or home was identified. An X-ray of his right thigh showed some bullet fragments and surgery was performed. He was also given chelation therapy with BAL and Ca-disodium-EDTA. His blood lead level gradually dropped to 48 µg/dL at the time of discharge although it then rebounded to 57 µg/dL where it remained until mid 2008. Levels were then recorded at 40 µg/dL and below.

Firearms (1)

A male in his 50s declined an interview but relayed that he was involved in competitive shooting and was exposed to lead during reloading. He volunteered that he is now under the medical care of a specialist and wears a respirator and gloves, while reloading. His two-year levels ranged from 37 µg/dL to a high of 55 µg/dL in 2008.

Pica (1)

A 16 year-old female was identified with a blood lead level of 50 µg/dL in 2008 through a prenatal blood lead screening. It was determined that her elevated lead was from pica behavior of chewing on scarves with metallic paint. The individual was developmentally delayed. She also had sickle cell anemia. Her baby was followed by MDCH CLPPP and chelated one day after birth with a birth blood level of 28 µg/dL. This decreased to 10 µg/dL with chelation.

In 2008, 688 (5.0%) of the 13,682 Michigan adults with blood lead tests reported had BLLs ≥ 10 µg/dL; 129 of those 688 (18.8%) had BLLs ≥ 25 µg/dL and 7 of 129 (5.4%) had BLLs ≥ 50 µg/dL (Table 1).

Eleven Years of Interviews of Adults with BLLs of 10 µg/dL or Greater

Between October 15, 1997, and December 31, 2008, there were 1,653 reports received on adults with BLLs ≥ 10 µg/dL who completed an interview by telephone. The following summary of interview data is based on the 1,653 questionnaires completed by telephone.

Most of the 1,653 completed questionnaires were of males (90.4%), which parallels the gender distribution from the 2008 year lead level reports ≥ 10 µg/dL. Although based on small numbers, the very highest BLLs (≥ 60 µg/dL) showed a higher percentage of African-Americans compared to lower blood lead levels. The percentage of ever or current smokers was higher among adults with the higher blood lead levels. The group with the highest lead levels had the youngest mean age (Table 10).

Table 10 Demographic Characteristics of Michigan Adults with BLLs ≥ 10 µg/dL interviewed INCLUSIVE 10/15/1997 to 12/31/2008 by Highest Reported BLLs

Demographic Characteristics	10-24 ug/dL		25-29 ug/dL		30-39 ug/dL		40-49 ug/dL		50-59 ug/dL		≥60 ug/dL		TOTAL	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Male	845	88.0	219	92.8	285	95.3	91	92.2	35	97.2	16	94.1	1491	90.5
Female	115	12.0	17	7.2	14	4.7	9	9.0	1	2.8	1	5.9	157	9.5
Hispanic Origin	50	5.4	9	4.1	11	3.8	12	12.4	1	2.9	0	—	83	5.3
Caucasian	814	86.0	206	88.8	260	88.1	85	85.0	33	91.7	14	82.4	1412	86.8
African American	81	8.6	13	5.6	19	6.4	8	8.0	3	8.3	3	17.6	127	7.8
Asian/Pacific Islander	3	0.3	1	0.4	2	0.7	0	—-	0	—-	0	—-	6	0.4
Native American/Alaskan	6	0.7	4	1.8	8	2.9	0	—-	0	—-	0	—-	18	1.1
Other	43	4.5	8	3.4	6	2.0	7	7.0	0	—-	0	—-	64	3.9
Average Age	45.0	n=960	43.7	n=236	42.0	n=299	43.62	n=100	42.6	n=36	356.0	n=17	44.1	n=1648
Ever Smoked	597	63.6	164	71.9	198	71.0	70	74.5	26	81.3	10	71.4	1065	67.2*
Now Smoke**	283	46.5	90	54.5	136	68.0	45	63.4	21	80.8	7	70.0	582	53.9*

*$p < 0.05$ for linear trend

** The percentages of *now* smoke are calculated using the denominator of those who *ever smoked*.

(Continued from page 23)

The higher blood leads were most common in high school graduates without any college education, high school graduates with 1-3 years of college or technical school, and in those who had not graduated high school. Higher blood leads were least common in those who had a 7th grade education or had completed 1-3 years of college (Table 11).

The types of lead-related symptoms reported during the interviews, by lead level, are presented in Table 12. Only individuals who had daily or weekly symptoms were included in this table. Loss of 10+ pounds without dieting, continued loss of appetite, frequent joint pain/soreness, headache, depression, being tired, feeling nervous, waking up at night, and being irritable were statistically significant as associated with increasingly higher levels of blood lead. Having any gastro-intestinal, musculoskeletal, nervous or reproductive system symptoms was also statistically associated with increasingly higher levels of blood lead. Table 13 and Figure 17 show the reporting of other health conditions, anemia, kidney disease, high blood pressure and hearing loss, by lead level category. Only high blood pressure was statistically significant as associated with increasing blood lead levels. *(Continued on page 27)*

Figure 17 Percentage Reporting Lead Related Health Conditions by Highest Reported BLL, Interviewed Adults INCLUSIVE 10/15/97 to 12/31/08

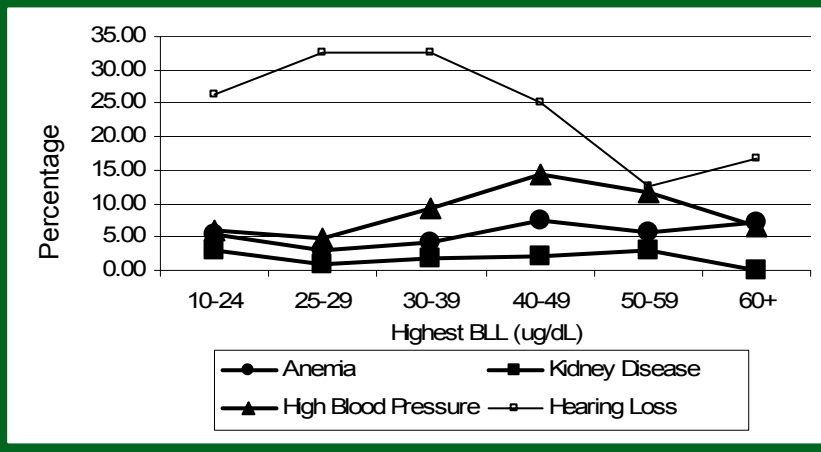


Table 11 Highest Education Level of Michigan Adults with BLLs ≥ 10 µg/dL Interviewed INCLUSIVE 10/15/97 to 12/31/08 by Highest Reported BLL

Highest Education Level	10-24 ug/dL		25-29 ug/dL		30-39ug/dL		40-49ug/dL		50-59 ug/dL		≥ 60 ug/dL		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
7th Grade or less	8	2.0	3	1.8	3	1.9	3	5.7	0	--	0	--	**27**	**2.1**
8th – 11th Grade	113	12.8	8	4.9	22	14.2	8	15.1	2	13.3	2	25.0	**155**	**12.1**
High School Grad	292	33.0	61	37.4	56	36.1	13	24.5	6	40.0	3	37.5	**431**	**33.7**
1-3 yrs College/Tech	294	33.3	66	40.5	47	30.3	18	34.0	5	33.3	1	12.5	**431**	**33.7**
4+ yrs College/Tech	167	18.9	25	15.3	27	17.4	11	20.8	2	13.3	2	25.0	**234**	**18.3**

Table 12 Symptoms of Michigan Adults with BLLs ≥ 10 µg/dL Interviewed INCLUSIVE 10/15/97 to 12/31/08 by Highest Reported BLL

Symptoms	10-24 µg/dL		25-29 µg/dL		30-39		40-49 µg/dL		50-59 µg/dL		≥ 60 µg/dL		Total	
	Number	Percent	Number	Percent	Number	Per-	Number	Percent	Number	Percent	Number	Percent	Number	Percent
GASTRO-INTESTINAL														
Lost 10+lbs w/o diet	98	10.4	17	7.5	33	11.2	33	20.6	7	20.6	4	26.7	181	11.3*
Continued loss of appetite	104	11.0	21	9.1	40	13.5	20	20.6	7	20.0	3	18.4	195	12.0*
Pains in belly	162	17.1	24	10.4	46	15.6	24	24.2	9	25.7	3	18.8	268	16.5
MUSCULOSKELETAL														
Frequent pain/sore joint	323	34.4	77	33.5	108	36.6	48	50.5	14	40.0	8	50.0	578	35.9*
Muscle weakness	228	24.4	3	13.1	55	18.9	33	34.0	12	34.3	7	43.8	365	22.8
NERVOUS														
Headaches	162	17.0	30	12.9	61	20.5	25	25.3	11	30.6	5	31.3	294	18.0*
Dizziness	98	10.4	14	6.0	17	5.8	12	12.2	4	11.4	6	37.5	151	9.3
Depressed	142	15.1	24	10.5	45	15.5	18	18.6	10	27.8	7	43.8	246	15.3*
Tired	349	37.1	72	31.0	136	46.1	53	54.1	21	58.3	9	56.3	640	39.6*
Nervous	132	14.1	24	10.4	47	16.2	22	22.2	10	28.6	6	37.5	241	15.0*
Waking up night	276	29.2	48	20.7	95	32.3	33	33.7	15	41.7	6	40.0	473	29.2*
Nightmares	65	6.9	5	2.2	13	4.5	6	6.2	4	11.4	3	18.8	98	6.0
Irritable	190	20.2	48	21.1	77	26.3	32	32.7	16	45.7	7	43.8	370	23.0
Unable to concentrate	157	16.7	23	12.2	57	19.3	18	18.8	9	25.0	4	25.0	273	16.9
REPRODUCTIVE														
Unable to have an erection	8	17.8	5	8.2	10	8.1	5	12.8	7	36.8	0	—	35	11.9
Trouble having a child	41	4.4	13	5.8	14	4.9	2	2.2	0	—	1	7.1	71	4.5
Gastro-Intestinal Symptoms	240	25.1	42	18.0	72	24.2	38	38.4	15	41.7	7	43.8	414	25.3*
Musculoskeletal Symptoms	378	40.0	80	34.6	117	39.7	54	55.1	16	45.7	9	56.3	654	40.3*
Nervous Symptoms	538	56.6	111	47.6	186	62.6	64	64.6	27	75.0	9	56.3	935	57.3*
Any Symptoms	**639**	**66.9**	**140**	**60.1**	**202**	**67.8**	**75**	**75.8**	**30**	**83.3**	**10**	**62.5**	**1096**	**67.0**
Average No. Symp-	**2.65**	**n=95**	**2.04**	**n=23**	**2.86**	**n=2**	**3.74**	**n=99**	**4.19**	**n=36**	**4.93**	**n=16**	**2.72**	**n=1637**

*p < 0.05 for linear trend

Table 13 Lead Related Health Conditions of Michigan Adults with BLLs of ≥ 10 µg/dL Interviewed INCLUSIVE 10/15/97 to 12/31/08 by Highest Reported BLL

Lead Related Disease	10-24 ug/dL		25-29 ug/dL		30-39 ug/dL		40-49 ug/dL		50-59 ug/dL		≥60 ug/dL		TOTAL	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Per-	Number	Percent	Number	Percent
Anemia	50	5.4	7	3.1	12	4.2	7	7.4	2	5.7	1	7.1	79	5.0
Kidney Disease	27	2.9	2	0.9	5	1.7	2	2.0	1	2.9	0	—	37	2.3
High Blood Pressure	57	6.1	11	4.8	27	9.3	13	14.3	4	11.8	1	6.7	113	7.1*
Hearing Loss	197	26.4	32	32.7	31	32.6	8	25.0	1	12.5	1	16.7	270	27.4

*p < 0.05 for linear trend

Table 14 Industry of Michigan Adults with BLLs of ≥ 10 µg/dL Interviewed INCLUSIVE 10/15/97 to 12/31/08 by Highest Reported BLL

Standard Industrial Classification	10-24 ug/dL		25-29 ug/dL		30-39ug/dL		40-49ug/dL		50-59 ug/dL		≥ 60 ug/dL		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Per-cent
Construction, Building(15)	17	3.1	3	1.7	0	—	0	—	0	—	0	—	20	1.9
Construction, Heavy (16)	16	2.9	1	0.6	3	1.3	0	—	0	—	0	—	20	1.9
Special Trade Construction (17)	172	31.6	43	24.7	77	33.3	30	42.3	13	41.9	7	50.0	342	32.1
Food and Kindred Products (20)	0	—	1	0.6	0	—	0	—	0	—	0	—	1	0.1
Lumber and Wood (24)	1	0.2	0	—	0	—	0	—	0	—	0	—	1	0.1
Furniture and Fixtures (25)	1	0.2	0	—	0	—	0	—	0	—	0	—	1	0.1
Printing and Publishing (27)	1	0.2	0	—	1	0.4	0	—	0	—	0	—	2	0.2
Chemicals and Allied Products (28)	0	—	0	—	1	0.4	0	—	0	—	0	—	1	0.1
Stone/Clay/Glass (32)	10	1.8	3	1.7	4	1.7	02	2.8	2	6.5	0	—	21	2.0
Primary Metals Industry (33)	52	9.6	52	29.9	84	36.4	22	31.0	8	25.8	4	28.6	222	20.8
Fabricated Metal Products (34)	60	11.0	21	12.1	18	7.8	5	7.0	0	—	0	—	104	9.8
Industrial, Comm. Machnry(35)	15	2.8	4	2.3	5	2.2	1	1.4	2	6.5	1	7.1	28	2.6
Electronics (36)	13	2.4	1	0.6	0	—	1	1.4	0	—	0	—	15	1.4
Transportation Equipment (37)	14	2.6	3	1.7	5	2.2	2	2.8	1	3.2	0	—	25	2.3
Measure, Analyze, Crtl Indstr (38)	1	0.2	0	—	0	—	0	—	0	—	0	—	1	0.1
Misc. Manufacturing Industries (39)	2	0.4	1	0.6	0	—	0	—	0	—	0	—	3	0.3
Railroad Transportation (40)	1	0.2	3	1.7	3	1.3	0	—	0	—	0	—	7	0.7
Motor Freight Trans, Whs (42)	1	0.2	0	—	0	—	0	—	0	—	0	—	1	0.1
Water Transportation (44)	2	0.4	0	—	0	—	0	—	0	—	0	—	2	0.2
Trans., Elect., Gas&San. Svcs. (49)	30	5.5	5	2.9	4	1.7	4	5.6	0	—	0	—	43	4.0
Wholesale-Durable Goods (50)	12	2.2	1	0.6	1	0.4	0	—	0	—	0	—	14	1.3
Building Materials, Hardware (52)	1	0.2	0	—	0	—	0	—	0	—	0	—	1	0.1
Automotive Dealers, Gas (55)	1	0.2	3	1.7	2	0.9	0	—	0	—	0	—	6	0.6
Other Retail Trade (59)	4	.07	0	—	1	0.4	0	—	0	—	0	—	5	0.5
Depository Institutions (60)	1	0.2	0	—	0	—	0	—	0	—	0	—	1	0.1
Finance, Insrns , Real Estate (65)	2	0.4	0	—	0	—	0	—	0	—	0	—	2	0.2
Business Services (73)	11	2.0	0	—	0	—	0	—	0	—	0	—	11	1.0
Automotive Repair Services (75)	20	3.7	7	4.0	6	2.6	4	5.6	2	6.5	0	—	39	3.7
Misc. Repair Services (76)	6	1.1	1	.06	3	1.3	0	—	0	—	0	—	10	0.9
Amusement and Recreation (79)	15	2.8	5	2.9	4	1.7	0	—	3	9.7	2	14.3	29	2.7
Health Services (80)	2	0.4	0	—	0	—	0	—	0	—	0	—	2	0.2
Educational Services (82)	11	2.0	3	1.7	1	0.4	0	—	0	—	0	—	15	1.4
Museum, Art Galleries (84)	1	0.2	1	0.6	0	—	0	—	0	—	0	—	2	0.2
Engineering Services (87)	13	2.4	3	1.7	2	0.9	0	—	0	—	0	—	18	1.7
Services, NEC (89)	2	0.4	0	—	0	—	0	—	0	—	0	—	2	0.2
General Government (91)	1	0.2	0	—	0	—	0	—	0	—	0	—	1	0.1
Justice, Public Order, Safety (92)	24	4.4	8	4.6	5	2.2	0	—	0	—	0	—	37	3.5
Human Resources (94)	0	—	0	—	1	0.4	0	—	0	—	0	—	1	0.1
Admin Environmental Quality (95)	1	1.2	0	—	0	—	0	—	0	—	0	—	1	0.1
Admin Economic Programs (96)	4	0.9	1	0.6	0	—	0	—	0	—	0	—	5	0.5
National Security Int'l Affairs (97)	3	0.6	0	—	0	—	0	—	0	—	0	—	3	0.3
TOTAL	**544**	**100.0**	**174**	**100.0**	**231**	**100.0**	**71**	**100.0**	**31**	**100.0**	**14**	**100.0**	**1065**	**100.0**

(Continued from page 24)

The type of industry by lead level reported among those interviewed overall shows that 32.1% worked in special trade construction and 20.8% worked in the primary metals industry (non-ferrous foundries). These two industries show the highest percentage workers for the higher blood leads (≥ 25 µg/dL), as well (Table 14). The number of years worked by highest lead level reported for the adults who completed a questionnaire (Table 15) show that higher blood lead level results were more likely to occur in shorter term workers (i.e. workers in a lead exposed job for five or fewer years).

Table 16 lists the types of working conditions reported by the interviewed adults, again by highest reported lead level. Workers with lower lead levels reported they were more likely to be tested at work as part of a company screening, have separate lockers, and have work clothing laundered at work, wash hands before eating, eat in a separate lunch room, and wear respirators as part of their lead work practices. As expected, workers more likely to have been removed from the job had the higher blood lead levels.

Table 15 Number of Years worked of Michigan Adults with BLLs of ≥ 10 µg/dL Interviewed INCLUSIVE 10/15/97 to 12/31/08 by Highest Reported BLL

Number of Years Worked	10-24 ug/dL		25-29 ug/dL		30-39 ug/dL		40-49 ug/dL		50-59 ug/dL		≥60 ug/dL		TOTAL	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
≤5	324	59.1	107	63.3	130	55.6	43	60.6	17	56.7	8	61.5	629	59.1
6—10	74	13.5	29	17.2	36	15.4	8	11.3	8	26.7	2	15.4	157	14.7
11—20	77	14.1	23	13.6	35	15.0	10	14.1	3	10.0	2	15.4	105	14.1
21—30	43	7.8	9	5.3	27	11.5	2	2.8	1	3.3	1	7.7	83	7.8
≥30	30	5.5	1	0.6	6	2.6	8	11.3	1	3.3	0	—	46	4.3

Table 16 Working Conditions Reported by Michigan Adults with BLLs ≥ 10 µg/dL Interviewed INCLUSIVE 10/15/97 to 12/31/08 by Highest Reported BLL

WORKING CONDITIONS	10-24 ug/dL		25-29 ug/dL		30-39ug/dL		40-49ug/dL		50-59 ug/dL		≥ 60 ug/dL		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Separate Lockers: dirty/clean+	287	53.8	119	70.0	158	69.6	40	56.3	20	62.5	4	33.3	628	60.1*
Work clothes laundered: work+	173	32.8	95	56.9	132	57.9	28	40.0	12	37.5	4	33.3	444	42.9*
Shower facility +	276	51.6	109	64.5	163	71.2	35	48.6	14	45.2	6	50.0	603	57.5
Lunch room available +	355	66.9	121	72.0	179	78.5	40	55.6	16	51.6	6	50.0	717	68.8
Clean off dust & wash hands before eating +	493	93.4	150	88.8	213	92.2	60	85.7	28	87.5	10	83.3	954	91.2*
Eat in lunchroom +	236	60.8	93	69.4	120	63.5	32	52.5	9	34.6	4	40.0	494	61.1*
Wear respirator +	336	62.5	119	70.4	173	74.5	56	78.9	21	65.6	10	83.3	715	67.8*
Smoke in work area ++	164	58.8	56	62.2	87	65.4	18	40.9	11	52.4	4	57.1	340	59.2
Keep cigarettes in pocket while	130	48.0	37	41.1	71	54.6	18	40.9	7	33.3	3	42.9	266	47.2
Exposed to lead now +	306	58.2	101	61.2	149	65.9	37	56.1	18	64.3	3	25.0	614	60.0
Removal from job +	28	5.2	13	7.6	30	13.1	17	24.3	9	28.1	5	41.7	102	9.7*
Tested as part of Co	414	43.4	150	63.8	204	68.7	52	52.5	23	63.9	8	47.1	851	51.9*

+ Based on **positive** questionnaire

++ Based on **negative** questionnaire

*p<0.05 for linear trend

Figures 13 and 14 depict the trends in the percent of working conditions and personal habits reported by the interviewed adults, by interview year, for the last ten years of surveillance. Figure 13 shows no clear trend in the number of individuals reporting separate lockers for street and work clothes, shower facility, work clothes laundered at work, an available lunch room and eating in a designated lunch room. All of these working conditions or work practices are measures that reduce lead exposure. Similarly there appears to be little change reported over the years in washing before eating. There is a lower percentage of workers reporting carrying cigarettes in exposed pockets into the work area.

Twenty-six percent of the adults interviewed reported children age 6 and younger living or spending time in the home (Table 17).

Figure 13 Percent of Individuals with BLLs ≥ 10µg/dL Trend of Working Conditions, Michigan, 2002—2008

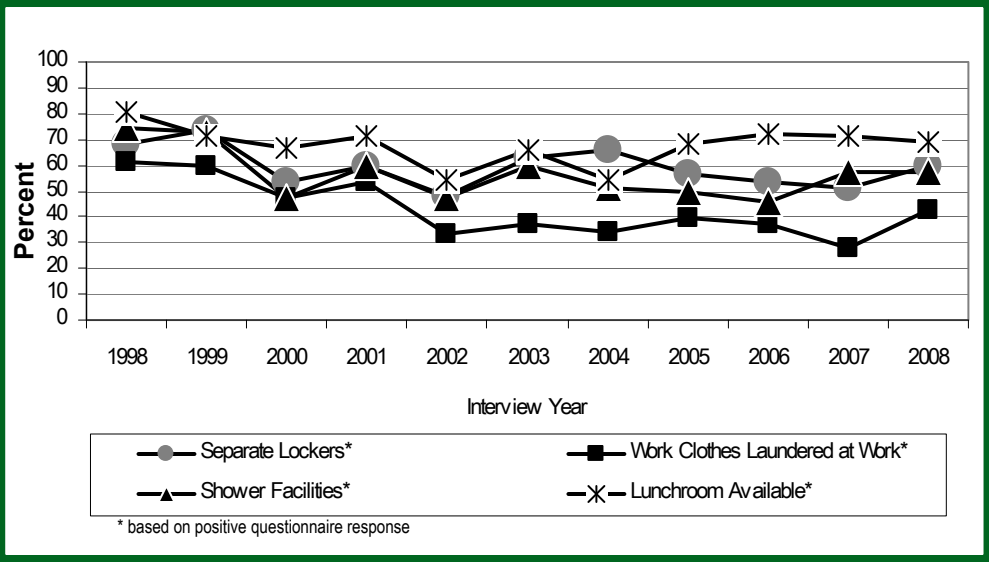


Figure 14 Percent of Individuals with BLLs ≥ 10µg/dL Trend of Personal Habits, Michigan, 2002—2008

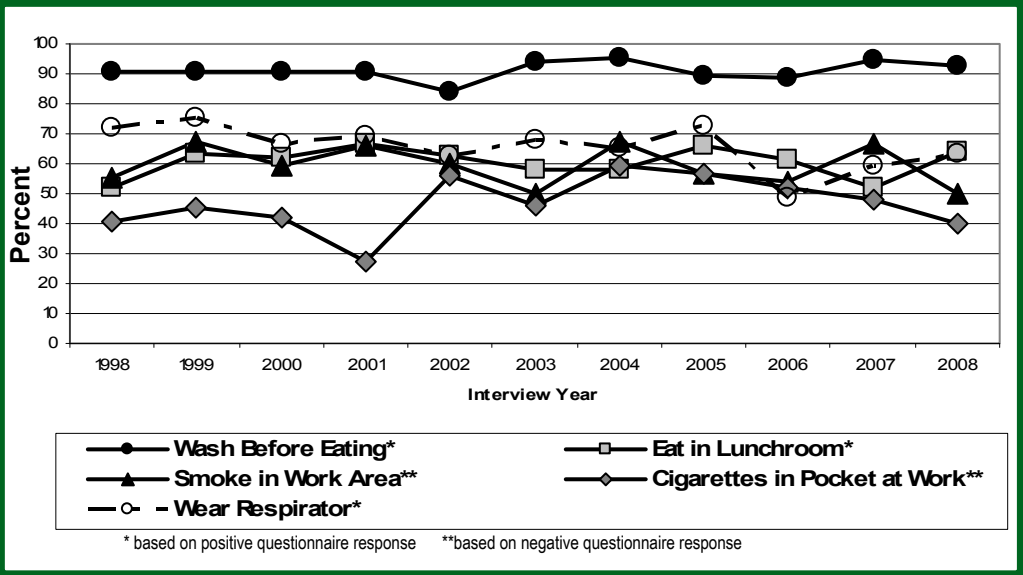


Table 17 Number of Households with Children (6 or under) Potentially Exposed to Take-Home Lead from Michigan Adults with BLLs ≥ 10 µg/dL INCLUSIVE Interviewed 10/15/97 to 12/31/2008, by Highest Reported BLL

Description of Households	10-24 ug/dL		25-29 ug/dL		30-39 ug/dL		40-49 ug/dL		50-59 ug/dL		≥ 60 ug/dL		Total	
	Num-	Percent	Num-	Percent	Num-	Percent	Num-	Percent	Num-	Percent	Num-	Percent	Num-	Per-
Households with Children Living or Spending Time	230	24.4	66	28.4	86	29.1	26	26.5	11	30.6	3	18.	422	26.0
Households with Children Tested for Lead	76	36.5	16	25.4	18	22.8	11	50.0	4	36.4	2	66.7	127	30.1
Households Where Children had Elevated Lead	25	35.7	3	20.0	8	40.0	4	40.0	1	33.3	1	50.0	42	33.1

*Among individuals within blood lead category, percentage of their households with children living or spending time in house.

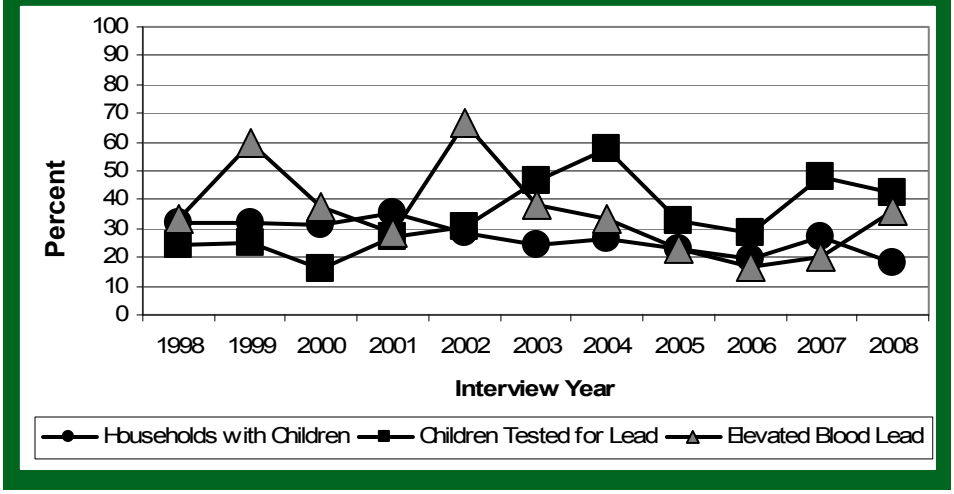
**Among individuals within blood lead category, percentage of "Households with Children Living/Spending Time", where the children were tested for lead. Because

***Among individuals within blood lead category, percentage of "Households w/Children Living/Spending Time ", where " Children Tested for Lead", had blood lead levels ≥ 10 µg/dL. Because of missing data, the denominator may be less than the "Children Tested for Lead" in the second row.

The questionnaire also asks about children in the household, in order to document the potential for and extent of take-home lead. Twenty-six percent of the adults interviewed reported children age 6 and younger living or spending time in the home (Table 17). Children from 127 of the 422 (30.1%) households where an adult had an elevated lead level and young children who lived or frequently visited were tested for blood lead. Among the 127 households where the child's blood test results were reported, 42 (33.1%) households had a child with an elevated blood lead level (≥ 10 µg/dL). A letter was sent to all adults encouraging them to test any children for lead age 6 and younger that lived or frequently visited their house.

Figure 15 depicts a yearly percent of households with children being tested for blood lead reported by the interviewed adults for the last eleven years of surveillance. In 2004, there was a peak of the percent of households with children tested for lead (58%). In 2005 and 2006 there was a marked decline, which increased again in the next two years. Testing these at-risk children in 2008 was only slightly higher (42%) than the eleven year average (33%). The percentage of households where results of these tests show children with elevated blood lead levels, peaked in 1999 and 2002, with 60% and 66%, respectively, and then decreased and were at their lowest value of 17% in 2006. This measure of lead workers' children with elevated lead levels has since increased in the last two years to 36 percent of those tested in 2008.

Figure 15 Trend of Percent Children Being Tested in Homes with Lead Exposed Adults BLL ≥10 µg/dL, Michigan 1998-2008



DISCUSSION

An individual may have a blood lead test performed as part of an employer medical-screening program or as part of a diagnostic evaluation by their personal physician. Whatever the reason for testing, the results are then sent by the testing laboratories to the MDCH as required by law. If the individual reported is an adult, the report is then forwarded to MSU and maintained in the ABLES program lead registry. Individuals with a blood lead level of 25 µg/dL or greater, and a sample of individuals with BLLs of 10-24 µg/dL, are interviewed by a trained interviewer by telephone. The interview includes detailed demographic information, exposure history and the presence and nature of lead related symptoms. When an individual from a company is identified with a blood lead value of 25 µg/dL or greater, a MIOSHA enforcement inspection is conducted to assess that company's compliance with the lead standard.

Michigan is one of 40 states conducting surveillance of elevated blood lead levels. Michigan requires the reporting of all BLL results, not just elevated levels. Major benefits for reporting all BLLs are the ability to calculate the rates of elevated BLLs in specific groups of interest, to monitor compliance with the testing requirements of the lead standard, and to facilitate the tracking of reports from particular employers to monitor their progress in reducing workers' exposures to lead.

Lead exposure remains an important public health concern in the U.S. Environmental Protection Agency (EPA) regulations requiring removal of lead from commercial products such as gasoline, house paint and solder in plumbing pipes and food cans, have greatly reduced exposure to lead in the general population. Average BLLs in the general population have dropped from 15 ug/dL in the 1970s to the current 1.45 µg/dL (8).

Occupational exposure has not declined as steeply as environmental lead exposure. Data from the 40 state lead surveillance system shows that nationally, 95% of adult elevated lead exposure is work-related (2). Occupational Safety and Health Administration (OSHA) lead standards, established in 1978 for general industry and in 1993 for construction, set the level for removal of a worker from lead exposure in general industry at 60 µg/dL and construction at 50 µg/dL. These levels were established when general population levels from environmental exposure were much higher than they are today.

Since then, thirty years of lead toxicity research has demonstrated that lead exposure at levels previously thought to be of little concern can result in an increased risk of adverse chronic health effects, especially if the exposure is maintained for many years, thereby resulting in a progressively larger cumulative dose (3-6). The level of lead in the blood is a direct index of a worker's recent exposure to lead as well as an indication of the potential for adverse effects from that exposure (9). The last 30 years of research on lead has shown health risks to lead exposure at levels as low as 5 ug/dL. Health risks to adults include increased blood pressure, which in turn increases the risk of heart disease and stroke, and chronic kidney disease(3,4).

Our interviews with Michigan workers show symptoms involving the gastrointestinal, musculoskeletal and nervous systems occurred at levels within the allowable MIOSHA and OSHA standards (Table 12). The presence of these symptoms supports the need to lower the blood lead level that mandates medical removal. Eighty-three percent of individuals in Michigan with blood lead below the general industry allowable level of 60 µg/dL had daily or weekly symptoms consistent with lead toxicity (Table 12). Toxic effects of lead can occur without overt symptoms.

While acute health effects from recent doses of lead are thought more likely to be reversible, chronic health effects due to long-term exposure are thought more likely to be irreversible in nature (6). Workers age 55 and older have exhibited cognitive decrements with higher levels of tibia lead (a measure of cumulative dose) (5,6).

Michigan occupations that risk lead exposure include abrasive blasting to remove lead paint from outdoor metal structures such as bridges, over-

passes or water towers; casting brass or bronze fixtures; fabricating metal products; or exposure to lead fumes or dust from firing guns or retrieval of spent bullets at firing ranges. While the use of lead in non-battery products has declined in the U.S. the use of lead worldwide continues to grow, especially in battery applications (10,11). Recycling the growing amount of "e-waste" created by discarded electronic and lead battery consumer products and the increased demand for raw metals and specifically recycled lead worldwide puts a new group of workers at risk to significant exposure to lead.

A further problem for Michigan families is that adults working in lead occupations may bring lead home on their shoes or clothes and expose their spouse and children. Only one in three families with someone exposed to lead at work report that their young children are tested for elevated lead. When these children are tested, 35% are found to have an elevated blood lead level (Table 17). While the number of children being tested for lead statewide has markedly increased, there has only been a slight increase of blood lead testing for the children of lead exposed workers (Figure 15). While Michigan's Childhood Lead Prevention Program reports in the 2007 Annual Report on Blood Lead Levels on Adults and Children in Michigan a successful reduction of the percentage of confirmed elevated BLLs from 7.2% in 1999 to 1.4% in 2007, when tested, lead workers' children have confirmed BLLs ≥ 10 µg/dL 33.1% of the time. Testing these children should become a priority for our state.

In 2008, there were 688 adults reported in Michigan with BLLs ≥ 10 µg/dL. Approximately ninety-six percent were men. The mean age was 44. They were predominately white (89%) and lived in a band of counties stretching across the state from Muskegon and Oceana to Wayne and Macomb. The source of exposure to lead was predominately occupational in origin (83.3%). Exposure occurred during the manufacture of non-ferrous metal parts such as plumbing fixtures, during abrasive blasting to remove paint from outdoor metal structures, during the fabricating of metal products, during the repair of car radiators or during work in indoor firing ranges.

Individuals with the highest blood leads were more likely to be younger (Table 10). We attribute this finding to a higher percentage of younger workers in construction doing abrasive blasting on metal structures. Also younger, less experienced workers may be given the dirtier, less desirable tasks.

Based on the experience in other states we presume that the number of reports of elevated BLLs we receive is an underestimate of the true number of Michigan citizens with elevated BLLs (12-13). For example, a study in California in the early 1990s reported that while 95% of lead battery employees had blood lead tests performed by their employers, only 8% of employees from radiator repair facilities and 34% of employees from secondary smelters of non-ferrous metal had blood lead testing performed by their employer (12). Overall it was estimated that less than 3% of employees in California exposed to lead were provided blood lead testing by their employer (13). On a national basis it was estimated that less than 12% of companies using lead provided blood lead testing for their employees (12). Our survey performed 15 years later on 28 Michigan radiator repair facilities showed only slightly better results with 25% performing blood testing for lead. MIOSHA inspected 11 radiator repair facilities that were not performing blood tests and found that seven (64%) were required by MIOSHA regulations to be performing such testing.

Seven Michigan adults were reported with BLLs above 50 µg/dL in 2008. Tests which, if repeated and averages above 50 µg/dL, are the maximum blood lead level allowed in the workplace. Three of the seven adults were exposed to lead at work (one from renovation and remodeling, one from bridge/highway construction, one from ship building and repair). The remaining four adults were exposed outside of work to lead from casting bullets, using firearms, pica behavior and one from a gun shot wound.

Current epidemiologic studies identified the need for OSHA to reevaluate and strengthen its lead standards so that workers are better pro-

tected from lead exposure (3). Substitutes of safer compounds, along with expanding education and outreach for employers and workers and their families would also contribute to lower lead levels. Ongoing surveillance in future years will continue to target and evaluate intervention activity to reduce exposure to lead.

In 2006 and 2008, a letter was sent to the ten OSHA approved Michigan laboratories that perform blood lead analysis, recommending the laboratories change the interpretative language of reference ranges of lead on their laboratory reports. The change would conform with the recommendations on medical management and prevention as outlined in Table 3 of an article published in Environmental Health Perspectives (7). This mini-monograph of articles documented the inadequacy of the current OSHA standard to protect against the health effects of lead. A follow-up review is underway to see if laboratories have complied.

In its eleventh year of operation, the surveillance system for lead continued to prove successful in identifying large numbers of adults with elevated lead levels and sources of exposure that could be remediated to reduce exposures in Michigan. The reduction in elevated blood lead levels, particularly from occupational exposures, has appeared to plateau (Figure 3). This plateau along with a deceased number of individuals who report preventive workplace practices to reduce lead at the facility where they were exposed to lead (Figure 13) has us concerned that the progress in previous years to reduce lead exposure has stalled. Continued outreach is planned to the medical community on the recognition and management of potential lead-related medical problems in both individuals and their young families. Reassessment of the current occupational lead standard is needed as health effects have been documented at levels allowed within the current standard. We are encouraged by the continued compliance with the reporting law by laboratories. We will continue to monitor for these trends in 2009.

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APPENDICES

Appendix A	Morbidity and Mortality Weekly Report (MMWR): Adult Blood Lead Epidemiology Surveillance --- United States, 2005--2007
Appendix B	Blood Lead Analysis Reporting
Appendix C	Summary of Michigan's Lead Standards
Appendix D	Table 1: Health Based Management Recommendations for Lead Exposed Adults, Environmental Health Perspective Vol. 115, No. 3 March 2007.

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MMWR Weekly

April 17, 2009 / 58(14);365-369

Adult Blood Lead Epidemiology and Surveillance --- United States, 2005--2007

Overexposure to inorganic lead continues to be an important health problem worldwide. Furthermore, recent research has caused increased concerns about the toxicity of lead at low doses (*1,2*). Lead can cause acute and chronic adverse effects in multiple organ systems, ranging from subclinical changes in function to symptomatic, life-threatening intoxication. Since 1992, CDC's state-based Adult Blood Lead Epidemiology and Surveillance (ABLES) program has tracked laboratory-reported elevated blood lead levels (BLLs) in U.S. adults. The vast majority (95%) of reported elevated BLLs have been work related. One of the *Healthy People 2010* national public health objectives is to reduce to zero the prevalence of BLLs ≥25 µg/dL among adults (objective 20-7) (*3*). ABLES surveillance results through 2004 have been published previously (*4*--*6*). This report summarizes results for the period 2005--2007. An overall decline in national rates of elevated BLLs among state residents plus nonresidents from 14.0 in 1994 to 7.8 in 2007 has been observed. The national rate of state resident adults with BLLs ≥25 µg/dL was 7.2 per 100,000 employed adults in 2005 and 7.4 in 2006 and 2007. Industry subsectors with the highest numbers of lead-exposed workers were manufacturing of storage batteries, mining of lead and zinc ores, and painting and paper hanging. The most common nonoccupational exposures were shooting firearms; remodeling, renovating, or painting; retained bullets (gunshot wounds); and eating food containing lead. These findings indicate a need for increased preventive interventions to promote healthier workplaces and help move toward the *Healthy People 2010* objective.

ABLES reporting benchmarks include BLLs ≥25 µg/dL and BLLs ≥40 µg/dL. State ABLES programs collect data on adult BLLs from laboratories and health-care providers through mandatory reporting requirements. ABLES states then intervene to prevent lead overexposures in worksites where elevated exposures occur. These interventions include 1) conducting follow-up interviews with physicians, employers, and workers; 2) investigating work sites; 3) providing technical assistance; 4) providing Occupational Safety and Health Administration (OSHA) referrals for consultation and enforcement; and 5) developing and disseminating educational materials and outreach programs.

A unique identifier is assigned to each person to account for multiple BLL reports. For BLLs ≥25 µg/dL, follow-up by telephone generally is conducted to ensure completeness of information on the industry where the

person works, exposure source (occupational or nonoccupational), and other variables. The industry where the person worked is coded using the 1987 Standard Industrial Classification (SIC) or the 2002 North American Industry Classification System (NAICS). BLL reporting requirements vary among ABLES states, ranging from the reporting of all BLLs to BLLs ≥40 µg/dL.* Most ABLES states submit data on all BLLs to CDC's National Institute for Occupational Safety and Health (NIOSH), including reports from persons whose BLLs fall below the state reporting requirement.

For this report, adults were considered to be all persons aged ≥16 years. For adults with more than one BLL result in a given year, only the highest BLL was included in this report. Elevated BLLs were defined as blood lead concentrations ≥25µg/dL. Rate numerators were "state resident" adults with elevated BLLs (adults residing in the reporting state) or "state residents plus nonresidents" adults with elevated BLLs (all adults reported by a state). Denominators were the annual employed population aged ≥16 years for the period 2005--2007 from the Current Population Survey.† To calculate yearly state prevalence rates, the numbers of adults with elevated BLLs from each state were divided by the state's annual employed population. The combined state numerators and denominators for each year were then used to calculate the national prevalence rate.§

Data were provided by 37 states in 2005, 38 states in 2006, and 38 states in 2007.¶ Overall, national rates of elevated BLLs declined from 14.0 per 100,000 employed adults in 1994 to 7.8 in 2007 (Figure 1). ABLES states reported 8,902, 9,562, and 9,871 state resident adults with elevated BLLs in 2005, 2006, and 2007, respectively. The national rate per 100,000 state resident adults with elevated BLLs declined 4%, from 7.5 in 2004 to 7.2 in 2005, but increased 3%, from 7.2 in 2005 to 7.4 in 2006 and 2007. State annual prevalence for 2005 ranged from 0.5 (Hawaii) to 34.0 (Kansas); for 2006, from 0.2 (Montana) to 32.3 (Pennsylvania); and for 2007, from 0.8 (New Mexico) to 36.4 (Missouri). Prevalence rates in 2007 were <10 in 29 states and ≥20 in six states (Figure 2).

Rates per 100,000 state resident adults with BLLs ≥40 µg/dL, a second ABLES reporting benchmark, were 1.2 in 2004 and 2005, 1.1 in 2006, and 1.2 in 2007. In 2005, prevalence rates ranged from 0.1 (Arizona and New Mexico) to 9.5 (Alabama). In 2006, prevalence rates ranged from 0.2 (Arizona) to 7.5 (Alabama). In 2007, prevalence rates ranged from 0.1 (Oklahoma) to 9.1 (Alabama).

Data on industry and exposure source were submitted by 33 states (7,492 state resident adults) in 2005, 35 states (8,230 state resident adults) in 2006, and 35 states (8,246 state resident adults) in 2007.** For this analysis, adults exposed to both occupational and nonoccupational sources (17 in 2005, 24 in 2006, and 11 in 2007) were considered exposed at work only. Exposures at work accounted for 5,861 (78.2%), 6,643 (80.7%), and 6,463 (76.7%) elevated BLLs in 2005, 2006, and 2007, respectively. The majority of adults with elevated BLLs were employed in three large industry sectors: manufacturing (64.8% in 2005 and 71.8% in 2006 and 2007), construction (15.2% in 2005, 12.6% in 2006, and 11.4% in 2007), and mining (9.4% in 2005, 9.5% in 2006, and 10.5% in 2007). Specific industry subsectors with the highest numbers were manufacturing of storage batteries, mining of lead and zinc ores, and painting and paper hanging (Table). Nonoccupational exposures accounted for 330 (4.4%), 380 (4.6%), and 350 (4.2%) adults in 2005, 2006, and 2007, respectively. Among these, the most common exposures were shooting firearms; remodeling, renovating, or painting; retained bullets (gunshot wounds); and eating food containing lead (Table).

Reported by: *WA Alarcon, MD, RJ Roscoe, MS, GM Calvert, MD, JR Graydon, Div of Surveillance, Hazard Evaluations, and Field Studies, National Institute for Occupational Safety and Health, CDC.*

Editorial Note:

ABLES surveillance results indicate an overall decreasing trend in the national prevalence rate of elevated BLLs in adults since 1994 (Figure 1), with a slight increase in the 2006 and 2007 rates. Part of the overall decrease might be the result of a decline in the number of manufacturing jobs with potential for lead exposure over time, in addition to prevention measures that have been enacted since the early 1990s, including 1) improved interventions by ABLES states, worker-affiliated organizations, and federal programs (e.g., NIOSH's ABLES surveillance†† and OSHA's National Emphasis Program to reduce lead exposure§§) and 2) measures implemented by industry (e.g., engineering controls, work practices, and respiratory protection). However, these rates might also reflect low employer compliance with testing and reporting requirements. A 2008 report using ABLES data found that only 29% of adults with BLLs requiring medical removal from work involving lead exposure received appropriate follow-up blood lead tests and met the eligibility criteria to return to their work (*7*). The slight increase in national rates in the ABLES data for 2006 and 2007 might have resulted from increased exposures at workplaces or improved testing and reporting. Changes in annual rates also might reflect increased or decreased surveillance activities by ABLES state programs.

ABLES data also indicate that excessive exposure to lead remains primarily an occupational health problem in the United States; 95% of adults with an identified exposure source were exposed at work. As in the past, during 2005--2007, these exposures occurred mainly in battery manufacturing, lead and zinc ores mining, and painting and paper hanging industry subsectors. The consistently higher proportions of adults with BLLs ≥40 µg/dL among those with BLLs ≥25 µg/dL observed in the painting and paper hanging, special trade contractors, and nonferrous foundries industries from 2005 through 2007 (Table 1) likely reflect higher lead exposures in these industries.

OSHA lead standards require removing a worker from lead exposure when the whole-blood lead concentrations ≥50 µg/dL for construction workers or ≥60 µg/dL for general industry workers, and permit return to work when their BLLs is ≤40 µg/dL (*8,9*). The current CDC/NIOSH surveillance case definition for elevated BLLs in adults is BLL ≥25 µg/dL. Recent research has consistently demonstrated the toxicity of lead from chronic dose exposures <30 µg/dL. Low-dose lead exposure can result in adverse effects in multiple organ systems, including effects in neurologic, cardiovascular, reproductive, and renal function (*1,2*).

CDC is making efforts to reduce occupational lead exposures through collaborations with state ABLES programs (by providing technical support and funding for surveillance); with worker-affiliated organizations (e.g., NIOSH cooperated with the Center for Construction Research and Training, formerly known as The Center to Protect Workers' Rights [CPWR], in analyzing lead exposures in the construction industry); and with OSHA. One of OSHA's National Emphasis Programs aims to reduce workplace lead exposure among all U.S. workers, and ABLES data are provided periodically to OSHA to help better target this program.

The findings in this report are subject to at least one limitation. The number of adults with elevated BLLs reported to ABLES likely is underreported because some employers might not provide BLL testing to all lead-exposed workers as required by OSHA regulations and because some laboratories might not report all tests as required by state regulations (*10*); these factors likely vary across the 38 participating ABLES states.

To further prevent workplace lead exposures and help move toward the *Healthy People 2010* objective, the following efforts need to be strengthened, particularly in industries with higher exposures: 1) worker protection programs developed and maintained by employers¶¶; 2) government efforts, such as state ABLES programs, the OSHA National Emphasis Program to reduce lead exposure, and the NIOSH ABLES program; 3) research and interventions by worker-affiliated organizations, such as the Center for Construction Research and Training; and 4) education of the public to prevent nonoccupational exposures.

Acknowledgments

This report is based, in part, contributions by ABLES state coordinators and by J Li, Div of Surveillance, Hazard Evaluations, and Field Studies, National Institute for Occupational Safety and Health, CDC.

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state-contacts.html.

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§ Information regarding interpretation of specific state ABLES data, definitions, and rate calculations is available at http://www.cdc.gov/niosh/topics/ables/ables.html.

¶ 38 states submitted data to ABLES in 2007: Alabama, Alaska, Arizona, California, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Utah, Washington, Wisconsin, and Wyoming. Tennessee data were not available for 2005. Louisiana data were not available for 2005 and 2006. Hawaii data were not available for 2007.

** States providing data on industry in 2007: Alaska, Arizona, California, Connecticut, Florida, Georgia, Illinois, Iowa, Kansas, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Utah, Washington, Wisconsin, and Wyoming. Industry data were not available for Louisiana for 2005 and 2006, Rhode Island for 2005, and Tennessee for 2005. Hawaii data were not available for 2007.

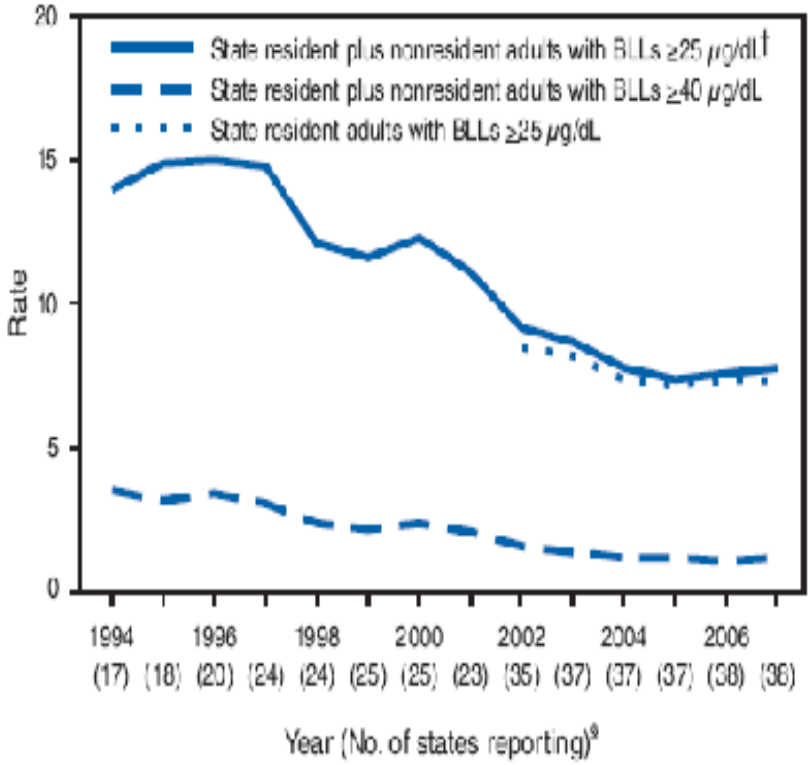
†† Information available at http://www.cdc.gov/niosh/topics/ables/ables.html.

§§ Information available at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=directives&p_id=2572.

¶¶ Elements of worker protection programs should include 1) hazard determination, including exposure assessment; 2) engineering and work practice controls; 3) respiratory protection; 4) protective clothing and equipment; 5) housekeeping; 6) hygiene facilities and practices; 7) medical surveillance and provisions for medical removal; 8) training; 9) signs; and 10) recordkeeping. Additional information available at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=fact_sheets&p_id=161.

FIGURE 1. National prevalence rates* of adults with elevated blood lead levels (BLLs), by year - Adult Blood Lead Epidemiology and Surveillance program, United States, 1994--2007

Adult Blood Lead Epidemiology and Surveillance — United States, 2005–2007



* Per 100,000 employed adults aged ≥16 years. Denominators for 2005-2007 extracted from 2008 U. S. Department of Labor, Bureau of labor Statistics Current Population Survey, available at http://www.bls.gov/data.

† State residents are adults residing in the reporting state. State residents plus nonresidents are all adults reported by a state.

§ 38 states submitted data in 2007: Alabama, Alaska, Arizona, California, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Utah, Washington, Wisconsin, and Wyoming. Tennessee data were not available for 2005. Louisiana data were not available for 2005 and 2006. Hawaii data were not available for 2007.

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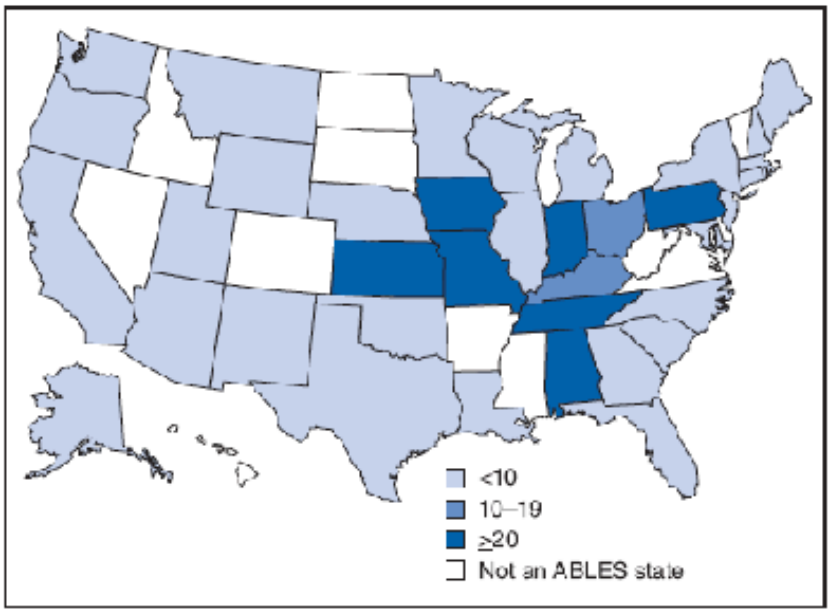
FIGURE 2. Annual state prevalence rate* categories for state resident adults† with elevated blood lead levels (≥25 µg/dL) - Adult Blood Lead Epidemiology and Surveillance (ABLES) program, United States, 2007§

Adult Blood Lead Epidemiology and Surveillance --- United States, 2005--2007



* Per 100,000 employed adults aged ≥16 years. Denominators for 2005--2007 extracted from 2008 U. S. Department of Labor, Bureau of labor Statistics Current Population Survey, available at http://www.bls.gov/data.

† State residents are adults residing in the reporting state.

§ 38 states submitted data in 2007: Alabama, Alaska, Arizona, California, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Utah, Washington, Wisconsin, and Wyoming. Tennessee data were not available for 2005. Louisiana data were not available for 2005 and 2006. Hawaii data were not available for 2007.

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TABLE. Number and percentage of resident adults with elevated blood lead levels (BLLs), by industry subsector and nonoccupational source of exposure - Adult Blood Lead Epidemiology and Surveillance (ABLES) program, United States, 2005-2007

Adult Blood Lead Epidemiology and Surveillance --- United States, 2005--2007

	2005 (33 states)				2006 (35 states)				2007 (34 states)			
	BLLs ≥25 µg/dL		BLLs ≥40 µg/dL		BLLs ≥25 µg/dL		BLLs ≥40 µg/dL		BLLs ≥25 µg/dL		BLLs ≥40 µg/dL	
Exposure type	No.	(%)†	No.	(%)§	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Occupational (Industry subsector [SIC and NAICS codes] *)												
Manufacturing, storage batteries (SIC 3691, NAICS 335911)	1,916	(32.7)	90	(4.7)	2,636	(39.7)	179	(6.8)	2,524	(39.1)	207	(8.2)
Metal mining, lead and zinc ores (SIC 1031, NAICS 212231)	542	(9.2)	71	(13.1)	625	(9.4)	109	(17.4)	672	(10.4)	127	(18.9)
Construction, painting and paper Hanging (SIC 1721, NAICS 237310 part, 238320 part)	527	(9.0)	144	(27.3)	495	(7.5)	130	(26.3)	399	(6.2)	117	(29.3)
Manufacturing, primary batteries (dry and wet) (SIC 3692, NAICS 335912)	187	(3.2)	22	(11.8)	597	(9.0)	92	(15.4)	573	(8.9)	126	(22.0)
Manufacturing, secondary smelting and refining of nonferrous metals (SIC 3341, NAICS 331314 part, 331423 part, 331492 part)	355	(6.1)	51	(14.4)	370	(5.6)	37	(10.0)	447	(6.9)	60	(13.4)
Manufacturing, primary smelting and refining of nonferrous metals (SIC 3339, NAICS 33419)	134	(2.3)	19	(14.2)	129	(1.9)	24	(18.6)	128	(2.0)	21	(16.4)
Construction, special trade contractors NEC¶ (SIC 1799, various NAICS codes in construction and services)	135	(2.3)	34	(25.2)	93	(1.4)	23	(24.7)	96	(1.5)	20	(20.8)
Manufacturing, copper foundries (SIC 3366, NAICS 331525)	125	(2.1)	16	(12.8)	112	(1.7)	18	(16.1)	78	(1.2)	11	(14.1)
Construction, bridge, tunnel, and elevated highway construction (SIC 1622, NAICS 237310 part, 237990 part)	67	(1.1)	9	(13.4)	87	(1.3)	12	(13.8)	34	(0.5)	5	(14.7)

Manufacturing, nonferrous foundries, except aluminum and copper (SIC 3369, NAICS 331528)	60	(1.0)	13	(21.7)	53	(0.8)	9	(17.0)	75	(1.2)	20	(26.7)
Manufacturing, rolling, drawing, and extruding of nonferrous metals (SIC 3356, NAICS 331491)	65	(1.1)	3	(4.6)	54	(0.8)	7	(13.0)	56	(0.9)	14	(25.0)
Services, automotive repair shops NEC (SIC 7539, NAICS 811118, 811198 part)	79	(1.3)	15	(19.0)	41	(0.6)	5	(12.2)	50	(0.8)	9	(18.0)
Manufacturing, steel works, blast furnaces (including coke ovens), and rolling mills (SIC 3312, NAICS 331111 part, 331221 part)	63	(1.1)	6	(9.5)	26	(0.4)	2	(7.7)	64	(1.0)	5	(7.8)
Other industries and unavailable information on industry**	1,606	(27.4)	302	(18.8)	1,325	(19.9)	207	(15.6)	1,267	(19.6)	215	(17.0)
Total exposed at work	5,861	(100.0)	795	(13.6)	6,643	(100.0)	854	(12.9)	6,463	(100.0)	957	(14.8)
Nonoccupational												
Shooting firearms (target shooting)	98	(29.7)	25	(25.5)	129	(33.9)	29	(22.5)	120	(34.3)	19	(15.8)
Remodeling/Renovation/Painting	58	(17.6)	15	(25.9)	49	(12.9)	9	(18.4)	51	(14.6)	15	(29.4)
Retained bullets (gunshot wounds)	17	(5.2)	4	(23.5)	30	(7.9)	15	(50.0)	35	(10.0)	10	(28.6)
Eating food containing lead	21	(6.4)	9	(42.9)	29	(7.6)	10	(34.5)	21	(6.0)	5	(23.8)
Casting (e.g., bullets and fishing weights)	14	(4.2)	5	(35.7)	13	(3.4)	4	(30.8)	20	(5.7)	6	(30.0)
Pica (i.e., the eating of nonfood items)	21	(6.4)	8	(38.1)	15	(3.9)	5	(33.3)	10	(2.9)	3	(30.0)
Complementary and alternative medicines	8	(2.4)	7	(87.5)	13	(3.4)	9	(69.2)	10	(2.9)	6	(60.0)
Retired††	11	(3.3)	2	(18.2)	3	(0.8)	2	(66.7)	8	(2.3)	1	(12.5)
Ceramics	-	-	-	-	-	-	-	-	3	(0.9)	2	(66.7)
Stained glass	3	(0.9)		-	-	-	-	-	-	-	-	-
Eating from leaded cookware	3	(0.9)	1	(33.3)	-	-	-	-	-	-	-	-
Drinking liquids containing lead (e.g., moonshine)	-	-	-	-	-	-	-	-	2	(0.6)	1	(50.0)

Other nonoccupational exposure	3	(0.9)	2	(66.7)	3	(0.8)	2	(66.7)	6	(1.7)	2	(33.3)
Unavailable nonoccupational source of exposure	73	(22.1)	19	(26.0)	96	(25.3)	27	(28.1)	64	(18.3)	15	(23.4)
Total exposed at places other than work	330	(100.0)	97	(29.4)	380	(100.0)	112	(29.5)	350	(100.0)	85	(24.3)

* Standard Industry Classification and North American Industry Classification System. Correspondence tables between 2002 NAICS and 1987 SIC are available from the U.S. Census Bureau at http://www.census.gov/epcd/naics02/index.html.

† Percentage of the total cases reported per year.

§ Percentage cases with elevated BLLs in each industry or nonoccupational exposure source.

¶ Not elsewhere classified.

** Information on industry was unavailable for 265 adults with BLLs ≥25 µg/dL and for three adults with BLLs ≥40 µg/dL in 2005; and in 88 adults with BLLs ≥25 µg/dL in 2006.

†† These adults might have been former lead workers. Available data show that two adults (BLLs 32 µg/dL and 34 µg/dL) retired from a radiator repair shop, one retired from the police (BLL 39 µg/dL), and one retired from a tire manufacturing industry (BLL 37 µg/dL).

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DEPARTMENT OF COMMUNITY HEALTH

HEALTH LEGISLATION AND POLICY DEVELOPMENT

BLOOD LEAD ANALYSIS REPORTING

Filed with the Secretary of State on September 25, 1997. These rules take effect 15 days after filing with the Secretary of State.

(By authority conferred on the community public health agency by section 5111 of Act No. 368 of the Public Acts of 1978, as amended, section 8 of Act No. 312 of the Public Acts of 1978, and Executive Reorganization Order No. 1996-1, being §§333.5111 and 325.78, and 330.3101 of the Michigan Compiled Laws)

R 325.9081 Definitions.

Rule 1. (1) As used in these rules:

(a) "Blood lead analysis report form" means the form used to report the required reportable information for blood that has been analyzed for lead.

(b) "Agency" means the community public health agency.

(c) "Physician/provider" means a licensed professional who provides health care services and who is authorized to request the analysis of blood specimens. For this purpose, provider may also mean the local health department.

(2) The term "local health department," as defined in Act No. 368 of the Public Acts of 1978, as amended, being §333.1101 et seq. of the Michigan Compiled Laws, has the same meaning when used in these rules.

R 325.9082 Reportable information.

Rule 2. (1) Reportable information is specifically related to blood samples submitted to clinical laboratories for lead analysis.

(2) Upon initiating a request for blood lead analysis, the physician/provider ordering the blood lead analysis shall complete the client information (section I) and the physician/provider information (section II) of a blood lead analysis report form designated by the agency or shall complete another similar form that ensures the inclusion of the same required data and shall provide all of the following information:

(a) All of the following information with respect to the individual tested:

(i) Name.

(ii) Sex.

(iii) Racial/ethnic group.

(iv) Birth date.

(v) Address, including county.

(vi) Telephone number.

(vii) Social security number and Medicaid number, if applicable.

(viii) If the individual is a minor, the name of a parent or guardian and social security number of the parent or guardian.

(ix) If the individual is an adult, the name of his or her employer.

(b) The date of the sample collection.

(c) The type of sample (capillary or venous).

(3) The blood lead analysis report form or a document with the same data shall be submitted with the sample for analysis to a clinical laboratory that performs blood lead analysis.

(4) Upon receipt of the blood sample for lead analysis, the clinical laboratory shall complete the laboratory information (section III) and provide all of the information required and/or submitted by the

physician/provider and the following:

(a) The name, address, and phone number of the laboratory.

(b) The date of analysis.

(c) The results of the blood lead analysis in micrograms of lead per deciliter of whole blood rounded to the nearest whole number.

R 325.9083 Reporting responsibilities.

Rule 3. (1) All clinical laboratories doing business in this state that analyze blood samples for lead shall report all blood lead results, rounded to the nearest whole number, for adults and children to the Community Public Health Agency, Childhood Lead Poisoning Prevention Program (CPHA/CLPPP), 3423 N.M.L. King Jr. Blvd., Lansing , MI 48909. Reports shall be made within 5 working days after test completion.

(2) Nothing in this rule shall be construed to relieve a laboratory from reporting results of a blood lead analysis to the physician or other health care provider who ordered the test or to any other entity as required by state, federal, or local statutes or regulations or in accordance with accepted standard of practice, except that reporting in compliance with this rule satisfies the blood lead reporting requirements of Act No. 368 of the Public Acts of 1978, as amended, being §333.1101 et seq. of the Michigan Compiled Laws.

R 325.9084 Electronic communications.

Rule 4. (1) A clinical laboratory may submit the data required in R 325.9083 electronically to the agency.

(2) For electronic reporting, upon mutual agreement between the reporting laboratory and the agency, the reporting shall utilize the data format specifications provided by the agency.

R 325.9085 Quality assurance.

Rule 5. For purposes of assuring the quality of submitted data, each reporting entity shall allow the agency to inspect copies of the medical records that will be submitted by the reporting entity to verify the accuracy of the submitted data. Only the portion of the medical record that pertains to the blood lead testing shall be submitted. The copies of the medical records shall not be recopied by the agency and shall be kept in a locked file cabinet when not being used. After verification of submitted data, the agency shall promptly destroy the copies of the medical records.

R 325.9086 Confidentiality of reports.

Rule 6. (1) The agency shall maintain the confidentiality of all reports of blood lead tests submitted to the agency and shall not release reports or any information that may be used to directly link the information to a particular individual, unless the agency has received written consent from the individual, or from the individual's parent or legal guardian, requesting the release of information.

(2) Medical and epidemiological information that is released to a legislative body shall not contain information that identifies a specific individual. Aggregate epidemiological information concerning the public health that is released to the public for informational purposes only shall not contain information that identifies a specific individual.

R 325.9087 Blood lead analysis report form.

Rule 7. The blood lead analysis report form reads as follows:

MICHIGAN DEPARTMENT OF COMMUNITY HEALTH
BLOOD LEAD ANALYSIS REPORT
DATA/INFORMATION REQUIRED BY ADMINISTRATIVE RULE # R325.9082 AND R 325.9083

PATIENT INFORMATION
To be completed by Parent/Guardian or Patient
PLEASE PRINT

Last Name _____ First Name _____ M. Initial _____

Address – No PO Boxes, please _____ Apt. # _____ City _____ State MI Zip _____

( ) Area Code and Phone Number _____ Birthdate (month/day/year) _____ Parent/Guardian Name (please print) _____

Race (Check all that apply):
- □ American Indian or Alaskan Native
- □ Asian
- □ Black or African American
- □ Native Hawaiian or Other Pacific Islander
- □ White
- □ Hispanic or Latino
- □ Middle Eastern or Arabic

Sex:
- □ Male
- □ Female

Funding Sources:
- □ Self Pay/Insurance
- □ Medicaid

ID# (Medicaid only): _____

If Patient is an adult (≥ 16 years):
Employer: _____
Social Security #: _____

PROVIDER/PHYSICIAN INFORMATION
To be completed by provider's office

Clinic, Hospital or Agency Name _____ Physician name _____

Mailing Address _____ City _____ State _____ Zip _____

( ) Area Code and Phone Number _____ Fax Number _____

SPECIMEN COLLECTION INFORMATION
To be completed by person who draws specimen

Specimen Collection Date _____ Source of Specimen □ Capillary □ Venous □ Filter Paper

LABORATORY INFORMATION
To be completed by testing laboratory

Laboratory Name _____ Specimen ID Number _____

( ) Area Code and Phone Number _____ Analysis Date _____

BLOOD LEAD LEVEL in Micrograms per Deciliter _____ (round to nearest whole number, please)

MDCH – Childhood Lead Poisoning Prevention Project, 3423 N. MLK Jr. Blvd, PO Box 30195, Lansing, MI 48909 (517) 335-8885
DCH-0395 (March 2004) Authority: Act 368, PA 1978 Fax (517) 335-8509

SUMMARY OF MICHIGAN'S LEAD STANDARDS

In 1981, under the authority of the Michigan Occupational Safety and Health Act (MIOSHA), Michigan promulgated a comprehensive standard to protect workers exposed to lead in general industry (i.e., R325.51901 - 325.51958). That standard was most recently amended in October, 2000. In October 1993, MIOSHA adopted by reference the federal Occupational Safety and Health Administration's (OSHA) Lead Standard for Construction (i.e., 29 CFR 1926.62). That standard was most recently amended October 18, 1999. Both the MIOSHA Lead Exposure in Construction Standard (Part 603) and the Lead Exposure in General Industry Standard (Part 310) establish an "action level" (30 micrograms of lead per cubic meter of air [ug/m^3] averaged over an eight-hour period) and a permissible exposure limit (50 ug/m^3 averaged over an eight hour period) for employees. Both standards require employers to conduct initial exposure monitoring and to provide employees written notification of these monitoring results. If employee exposure levels exceed the permissible exposure limit (PEL), employers are required to develop a written compliance program that addresses the implementation of feasible engineering and/or work practice controls to reduce and maintain employee exposures below the PEL. The Lead Exposure in Construction Standard (Part 603) also allows the use of administrative controls to achieve this objective. An employer's obligations concerning hygiene facilities, protective work clothing and equipment, respiratory protection, medical surveillance and training under the Lead Exposure in Construction Standard (Part 603) are triggered initially by job tasks and secondarily by actual employee exposure level to lead. Under the Lead Exposure in General Industry Standard (Part 310), these potential obligations are triggered by actual employee exposure levels to lead. Medical surveillance and training are triggered by exposures above the action level (AL), whereas protective clothing and equipment, respiratory protection and hygiene facilities are triggered by exposures above the PEL.

The medical surveillance program requirements for Michigan's Lead Exposure in General Industry Standard (Part 310) versus those required in Lead Exposure in Construction Standard (Part 603) do vary. Under the Lead Exposure in General Industry Standard (Part 310), a medical surveillance program must be implemented which includes periodic biological monitoring (blood tests for lead and zinc protoporphyrin [ZPP] levels), and medical exams/consultation for all workers exposed more than 30 days per year to lead levels exceeding the AL. Under the Lead Exposure in Construction Standard (Part 603), a distinction is made between "initial medical surveillance" (consisting of biological monitoring in the form of blood sampling and analysis for lead and ZPP levels) and secondary medical surveillance (consisting of follow-up biological monitoring and a medical examination/consultation). The initial medical exam is triggered by employee exposure to lead on any day at or above the AL. The secondary medical exam is triggered by employee exposures to lead at or above the AL for more than 30 days in any 12 consecutive months period.

Michigan's Lead Exposure in General Industry Standard (Part 310) mandates that employees exposed at or above the AL must be removed from the lead exposure when:

- A periodic blood test and follow-up blood test indicate that the blood lead level (BLL) is at or above 60 micrograms per deciliter (μg/dL) of whole blood.
- Medical removal is also triggered if the average of the last three BLL or the average of all blood sampling tests conducted over the previous six months, whichever is longer, indicates the employees blood lead level is at or above 50 μg/dL. Medical removal is not required however, if the last blood sampling test indicates a blood lead level at or below 40 μg/dL of whole blood.
- When a final medical determination reveals that an employee has a detected medical condition which places that employee at an increased risk of material impairment to health from the lead exposure.

The Lead Exposure in Construction Standard (Part 603) mandates removal of an employee from a lead exposure at or above the AL when:

- A periodic and follow-up blood test indicates that an employee's BLL is at or above 50 μg/dL; or
- There is a final medical determination that an employee has a detected medical condition which places that employee at an increased risk of material impairment to health from the lead exposure.

When an employee can return to work at their former job also differs by standard. The Lead Exposure in General Industry Standard (Part 310) allows an employee to return to his or her former job status under any of the following circumstances:

- If the employee's BLL was at or above 70 µg/dL, then two consecutive blood tests must have the BLL at or below 50 µg/dL.
- If the employee's BLL was at or above 60 µg/dL or due to an average BLL at or above 50 µg/dL, then two consecutive BLL must be at or below 40 µg/dL.
- For an employee removed due to a final medical determination, when a subsequent medical determination no longer detects a medical condition which places the employee at an increased risk of material impairment to health from exposure to lead.

The Lead Exposure in Construction Standard (Part 603) allows the employer to return an employee to their former job status under these circumstances:

- If the employee's BLL was at or above 50 µg/dL, then two consecutive blood tests must have the employee's BLL at or below 40 µg/dL.
- For an employee removed due to a final medical determination, when a subsequent medical determination no longer has a detected medical condition which places the employee at an increased risk of material impairment to health from exposure to lead.

Both the Lead Exposure in General Industry (Part 310) and Lead Exposure in Construction (Part 603) Standards have a medical removal protection benefits provision. This provision requires employers maintain full earnings, seniority and other employment rights and benefits of temporarily removed employees up to 18 months on each occasion that an employee is removed from exposure to lead. This includes the right to their former job status as though the employee had not been medically removed from the job or otherwise medically limited.

Provisions of Lead Exposure in General Industry (Part 310) and Lead Exposure in Construction (Part 603) Standards

Workers exposed to lead have a right to: an exposure assessment, respiratory protection, protective clothing and equipment, hygiene facilities, medical surveillance, medical removal and training. The triggering mechanisms that activate these rights are primarily based upon employee lead exposure levels. However, under the Lead Exposure in Construction Standard (Part 603), many of these rights are initially triggered by the specific work activity being performed.

Exposure Assessment

Air monitoring must be conducted to determine employee airborne lead exposure levels when a potential lead exposure exists. Under the Lead Exposure in Construction Standard (Part 603), however, specific work activities are identified/categorized that require "interim protection" (i.e., respiratory protection, personal protective clothing and equipment, work clothes change areas, hand washing facilities, biological monitoring and training) until air monitoring has been performed that establishes that these lead exposure levels are within the acceptable limits (AL or PEL).

Respiratory Protection

Respiratory protection is required whenever employee exposure levels exceed the PEL and as an interim control measure under the Lead Exposure in Construction Standard (Part 603). The level of respiratory protection required is dependent upon the actual employee exposure level or by the job activities identified in the Lead Exposure in Construction Standard (Part 603).

Protective Clothing/Equipment

Protective clothing/equipment (i.e., coveralls or similar full body clothing; gloves, hats, shoes or disposable shoe coverlets; and face shield, vented goggles, or other applicable equipment) is required whenever employee exposure levels exceed the PEL and as an interim protection measure under the Lead Exposure in Construction Standard (Part 603).

Hygiene Facilities

Hygiene facilities (i.e., clothing change areas, showers, eating facilities) are required whenever employee exposures to lead exceed the PEL. Except for shower facilities, these same hygiene facilities must be provided as interim protection under the Lead Exposure in Construction Standard (Part 603). The construction employer must, however, provide hand washing facilities in lieu of the shower facility as an interim protection.

Medical Surveillance

Medical surveillance (i.e., medical exam and consultation) is required when workers are exposed to lead at or exceeding the AL for more than 30 days a year. Biological blood sampling and analysis to determine lead and ZPP levels is required initially under the Lead Exposure in Construction Standard (Part 603) when employee lead exposure is at or exceeds the AL on any single day. Under the Lead Exposure in General Industry Standard (Part 310), it is required when employees are exposed to concentrations of airborne lead greater than the A.L. for more than 30 days per year.

Medical Removal

Workers covered by the Lead Exposure in General Industry (Part 310) Standard have the right to be removed from airborne lead exposures at or above the AL when their periodic and follow-up blood lead level is at or above 60 µg/dL or when an average of the last three BLLs or the average of all blood sampling tests conducted over the previous six months, whichever is longer, indicates the employee blood lead level is at or above 50 µg/dL. However, under this later removal criteria, they are not required to be removed if the last blood sampling test indicates a blood lead level at or below 40 µg/dL.

Workers covered by the Lead Exposure in Construction Standard (Part 603) have the right to be removed from airborne lead exposures at or above the AL on each occasion that a periodic and follow-up blood sample test indicate that the employee's blood lead level is at or above 50 µg/dL.

Under both the Lead Exposure in General Industry (Part 310) and Lead Exposure in Construction (Part 603) Standards, workers also have the right to be removed from airborne lead exposures at or above the AL whenever there is a final medical determination that has detected that they have a medical condition that places them at an increased risk of material impairment to health from exposure to lead.

Training

Under the Lead Exposure in General Industry Standard (Part 310) and Lead Exposure in Construction (Part 603), employees exposed to any level of airborne lead must be informed of the contents of appendices A and B from that standard.

Under both the Lead Exposure in General Industry (Part 310) and Lead Exposure in Construction (Part 603) Standards, employees who are exposed at or above the AL on any day or who are subject to exposure to lead compounds which may cause skin or eye irritation must be provided comprehensive training covering all topics specified in those standards.

Also, under the Lead Exposure in Construction Standard (Part 603), employees involved in any of the specified work activities requiring interim controls, must receive training prior to initiating those activities that addresses the recognition and avoidance of unsafe conditions involving lead and the specific regulations applicable to the worksite that have been established to control or eliminate the hazards associated with exposure to lead.

Table 1. **Health– based management recommendations for lead-exposed adults**

Volume 115; Number 3; March 2007 Environmental Health Perspectives

Blood lead level (µg/dL)	Short-term risks (lead exposure <1 year)	Long-term risks (lead exposure ≥ 1 year)	Management
<5	None documented	None documented	None Indicated
5-9	Possible spontaneous abortion Possible postnatal developmental delay	Possible spontaneous abortion Possible postnatal developmental delay Possible hypertension and kidney dys-function	Discuss health risks Reduce lead exposure for women who are or may become pregnant
10-19	Possible spontaneous abortion Possible postnatal developmental delay Reduced birth weight	Possible spontaneous abortion Possible postnatal developmental delay Hypertension and kidney dysfunction Reduced birth weight Possible subclinical neurocognitive deficits	Discuss health risks Reduce lead exposure for women who are or may become pregnant Decrease lead exposure Increase biological monitoring Consider removal from lead exposure to avoid long-term risks if exposure control over an extended period does not de-crease BLL<10 µg/dL or if medical condi-tion present that increases risk with con-tinued exposure
20-29	Possible spontaneous abortion Possible postnatal developmental delay Reduced birth weight	Possible spontaneous abortion Possible postnatal developmental delay Hypertension and kidney dysfunction Reduced birth weight Possible subclinical neurocognitive deficits	Remove from lead exposure if repeat BLL measured in 4 weeks remains ≥20 µg/dL
30-39	Spontaneous abortion Possible postnatal developmental delay Reduced birth weight	Spontaneous abortion Possible postnatal developmental delay Hypertension and kidney dysfunction Reduced birth weight Possible subclinical neurocognitive deficits Possible nonspecific symptoms*	Remove from lead exposure
40-79	Spontaneous abortion Possible postnatal developmental delay Reduced birth weight Nonspecific symptoms* Neurocognitive deficits Sperm abnormalities	Spontaneous abortion Possible postnatal developmental delay Hypertension Kidney dysfunction/neuropathy Subclinical peripheral neuropathy Reduced birth weight Neurocognitive deficits Nonspecific symptoms* Sperm abnormalities Anemia Colic Possible gout	Remove from lead exposure Refer for prompt medical evaluation Consider chelation therapy for BLL > 50 µg/dL with significant symptoms or signs of lead toxicity
≥90	Spontaneous abortion Possible postnatal developmental delay Reduced birth weight Nonspecific symptoms* Neurocognitive deficits Sperm abnormalities Encephalopathy Anemia Colic	Spontaneous abortion Possible postnatal developmental delay Hypertension Neuropathy Peripheral neuropathy Reduced birth weight Neurocognitive deficits Nonspecific symptoms* Sperm abnormalities Anemia Colic Gout	Remove from lead exposure Refer for immediate/urgent medical evaluation Probable chelation therapy

*Medical conditions that may increase the risk of continued exposure include chronic renal dysfunctions (serum creatinine > 1.5 mg/dL for women or protein urial, hypertension , neurologic disorders and cognitive dysfunction. Non specific symptoms may include headache, fatigue, sleep disturbance, anorexia, constipation, orthralgia, myalgia, and decreased libido.

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Occupational exposure to lead accounts for 95% of elevated blood lead levels in the U.S. (2).

Michigan's 2008 lead surveillance show that of the 16.7 % of individuals with elevated BLLs from non-occupational sources, 73% are exposed from a hobby related to guns.

There are many resources available to help employers, employees, health care professionals and others understand more about lead exposure, prevention and medical management. Links to these resources can be found at: ***www.oem.msu.edu***.

The Adult Blood Lead Epidemiology and Surveillance (ABLES) Program is a state-based surveillance program of laboratory-reported adult blood lead levels. The ABLES Program was founded nationally in 1992. In 1997 Michigan Occupational Safety & Health Administration began receiving money from the Centers for Disease Control and Prevention (CDC), to monitor adult BLLs as part of the ABLES Program.

The public health objective of the ABLES program is objective 20.7 in Healthy People 2010, which is to reduce the rate of adults (age 16 or older) who have blood lead levels of 25 micrograms per deciliter (mcg/dL) or greater. The ABLES program aims to accomplish this objective by building state capacity to initiate or improve adult blood lead surveillance programs which can accurately measure trends in adult blood lead levels and which can effectively intervene to prevent lead over-exposures.