Understanding the Problem of Lead in St. Joseph County, Indiana

From 2005-15

Prepared by:

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Acronyms

CDC	Centers for Disease Control and Prevention
EBLL	Elevated Blood Lead Level
EPA	Environmental Protection Agency
ISDH	Indiana State Department of Health
NHANES	National Health and Nutrition Examination Survey
Pb	Lead
SJC	St. Joseph County
SJCHD	St. Joseph County Health Department

Definitions

Screening	Represents established guidelines that are used to identify the presence or absence of lead
Test	Represents a single lead test and has a corresponding lead result; a unique individual may have one or more lead tests in the dataset.
Unique Individual	Represents one (1) unique individual person; a unique individual may have one or more lead tests in the dataset

EXECUTIVE SUMMARY

Lead exposure in SJC continues to be a persistent, complex public health issue. Data released in December 2016 showed that census tract 6 in South Bend had the highest rates of EBLL in the state of Indiana. Because lead exposure can produce significant cognitive and physiological damage even at very low levels of exposure, immediate action was required.

Understanding what the epidemiologic profile of lead in SJC was among the first steps taken to address this issue. The St. Joseph County Health Department requested assistance from the Eck Institute for Global Health at the University Of Notre Dame to analyze the 2005 – 2015 lead screening dataset. After consultation with SJCHD's Health Officer, the ND team developed two goals: (1) to conduct an in-depth analysis of lead screening data in SJC and (2) to make recommendations for improved data collection and improved screening practices in SJC.

A secondary, quantitative analysis was conducted on SJCHD's 2005 – 2015 lead dataset. There were several major findings. First, lead screening rates in SJC are very low at less than 10%. Second, children under 7 years of age represented 87.7% of individuals screened for lead. Third, seven census tracts had at least 20% of children under 7 years of age screened with an EBLL >= 5µg/dL; census tract 4, 6, 19, 21, 22, 27 and 30. Census tract 6 was the highest at 36.4%. Fourth, data collection is very poor resulting in over one-third to one-half of all variables indicating a null, unknown or data entry error. Fifth, of the 19,941 <7 year olds screened, there were 333 EBLL >= 10µg/dL and 1,589 EBLL 5 – 9.9 µg/dL. This suggests about a 1:5 ratio resulting in case management implications. Finally, pregnant women are underrepresented in the dataset with just four women accurately identified as pregnant.

The analysis brought to the surface the need to re-focus efforts on children under 7 and pregnant and lactating women. The CDC guidelines for screening and management of these populations are well established. Efforts to increase awareness, affect policy and improve lead screening and management are essential.

As a result, the ND team has made the following recommendations:

1. Improve screening rates significantly
2. Improve data collection
3. Implement the CDC guidelines to case manage EBLLs >5µg/dL
4. Implement the CDC guidelines for screening and management of pregnant and lactating women who have been exposed to lead

INTRODUCTION / BACKGROUND

The Problem of Lead

Lead (Pb) is a naturally occurring, nonessential, toxic heavy metal. The dangers of lead exposure have long been known, but knowledge of lead exposure on the human body at low levels is relatively recent. Blood lead levels once thought safe are now considered hazardous. Simply stated, there is no safe level of lead. Lead exposure effects include but are not limited to irreversible developmental delays, attention deficit hyperactivity disorder, behavioral disturbances, renal disease, and cardiovascular effects (CDC, 2017; Tarrago & Brown, 2017; Binns, Campbell, & Brown, 2016). Infants and children under the age of 7 are most susceptible to lead poisoning and may suffer from physical and mental development, behavior problems, and lower IQ levels (CDC 2017; Binns, Campbell, & Brown, 2016; Winneke, Brockhaus, Ewers, Kramer, & Neuf, 1990). These cognitive and developmental delays may lead to lower educational attainment, lower socio-economic status, and criminality for some individuals (Bellinger, 2017; Mielke & Zahran, 2012). Maternal exposure has been associated with increased risk of gestational hypertension, but as the level of exposure increases so does its effect on the fetus. Exposure to high levels of lead significantly increases risk of spontaneous abortion and may lead to low birth weight (CDC, 2010; AGOC, 2012).

All races and ethnicities are at risk for adverse health effects due to EBLL (Tarrago & Brown, 2017). Poverty, substandard housing, lower socio-economic status, members of minority racial and ethnic groups, and parents who may have exposure to occupational lead represent risk factors associated with lead exposure (CDC, 2015; Tarrago & Brown, 2017).

Sources of Lead

The most common sources of lead exposure in the United States are lead-based paints, contaminated soils, and household dust (EPA, 2017). Deteriorated lead paint (banned in the US in 1978) and interior dust in aged housing remains the most common source of lead exposure in the United States due to aged paint chalking, leaching, chipping and weathering. Potential interior exposure can be caused by the deterioration of friction impact surfaces like windowsills, doors, and frames coated with contaminated paint. Lead-based paint is a common source of ingestible leaded dust and creates a strong potential for lead exposure and human contamination (EPA, 2017). Leaded gasoline was also a source of environmental contamination but phased out in the U.S. by 1996 (EPA, 2017). The environmental aerial lead deposition from gasoline resulted in the greatest quantities of contaminated dust and soils (EPA, 2017). Thus, urban soils have been contaminated with lead, primarily from deteriorated lead based paint and past use of lead in gasoline, as well as from lead smelters and industry (Mielke, Laidlaw, & Gonzalez, 2011).

Screening Guidelines

In 2012, based on the 97.5th percentile of the National Health and Nutrition Examination Survey's (NHANES) blood lead distribution in children, the CDC lowered the reference level of an elevated blood lead level (EBLL) from >=10μg/dL to >=5 μg/dL (CDC, 2017). Thus, an EBLL >= 5 μg/dL requires case management. The CDC estimates over 500,000 US children have EBLLs >= 5 μg/dL. Given the estimated prevalence of lead exposure among children, CDC recommends universal screening of children under 7 years of age. It is recommended that lead screening be performed at 12 and 24 months of age and between 36 to 72 months for children not previously screened (CDC, 2017). Federal law requires that children enrolled in Medicaid meet the CDC screening requirements. Nationally, lead screening among children 5 and under is very low and Indiana is no exception. In 2015, there were 507,139 children under 72 months in the state, but only 4% of them were screened for lead (ISDH, 2015).

Per the CDC lead screening and management guidelines, case management services are activated for children under 7 years of age with a confirmed EBLL >= 5 μg/dL. A child becomes a confirmed case when they receive one venous test or two capillary blood tests with a result >=5 μg/dL. In Indiana, however, the administrative code states that case management is activated at EBLL >= 10 μg/dL (Indiana Administrative Code, 2009; ISDH, 2013). Once confirmed as a case, the case manager is required to notify the child's primary care provider, conduct an initial home visit and provide an environmental assessment (Indiana Administrative Code, 2009; ISDH, 2013).

Purpose Statement

The purpose of this report is two-fold: (1) to conduct an in-depth analysis of lead screening data in St. Joseph County (SJC) from 2005-2015, and (2) to make recommendations for improved data collection and improved screening practices in SJC. This report is intended to provide health agencies, legislators, health care professionals, government officials, researchers and community based organizations information on lead exposure in SJC. The information will allow for all to make data driven decisions intended to combat the problem in this community, and specifically it will help inform the St. Joseph County Health Department's (SJCHD) Lead Action Plan released in January 2017.

METHODS

Data Source

A secondary, quantitative analysis was conducted on SJCHD's 2005 – 2015 lead dataset. To ensure confidentiality and adherence to HIPPA regulations, the dataset was de-identified by SJCHD. Names and addresses were removed; however, a unique identifier was added to ensure uniqueness among individuals. The dataset included 47 variables which included but was not limited to: age, sex, race, ethnicity, census tract, pregnancy status, Medicaid status, healthcare provider information, laboratory provider information, source of testing (venous or capillary blood test), testing reason, date of lead test, and test result.

Data Analysis

The dataset contained 35,936 records from 2005-2015. Each record represents one lead test; the dataset included 47 variables for each test. After reviewing the data, duplicates were identified and eliminated if multiple records had the same unique identifier, specimen date, and lead level. t. Additionally, records were eliminated if the data had the same unique identifier, specimen date and date of birth BUT the lead level was different or the data had the same unique identifier BUT different date of birth.

After eliminating data that met the above exclusion criteria, there were 28,764 tests and 23,256 unique individuals in the dataset.

Nearly 30 of the 47 variables were poorly populated with 26 of them missing data in at least half of the records. Key fields missing information included race, ethnicity, and Medicaid status. The other 4 poorly populated variables included provider, sample type (capillary, venous), and test reason (routine, confirmatory) and were missing data in at least one third of the records. Actual missing data was coded as unknowns or null, while sometimes 'unidentified' was present. The lack of complete data presented a challenge in data analysis.

Data were analyzed with multiple software packages. Statistical analyses were calculated with programs including SPSS (version 24), R (version 3.4.0) and Microsoft Excel 2015. Geographic information systems (ArcGIS) techniques were used to assemble demographic and socioeconomic indicators to capture, analyze, and integrate spatial data infrastructure of SJC.

RESULTS

Demographics

Unique individuals tested for lead in St. Joseph County from 2005-15 were 50.8% female and 48.5% male (see Table 1). Race was not recorded for 31.5% of individuals. For the other 68.5%, 42.0% were white, 19.4% were black, and 6.5% fell into other categories. Ethnicity was only recorded for 47.8% of individuals and of those 32.5% were non-Hispanic and 15.3% were Hispanic.

Table 1: Demographics of Unique Individuals (n=23,256) and EBLL

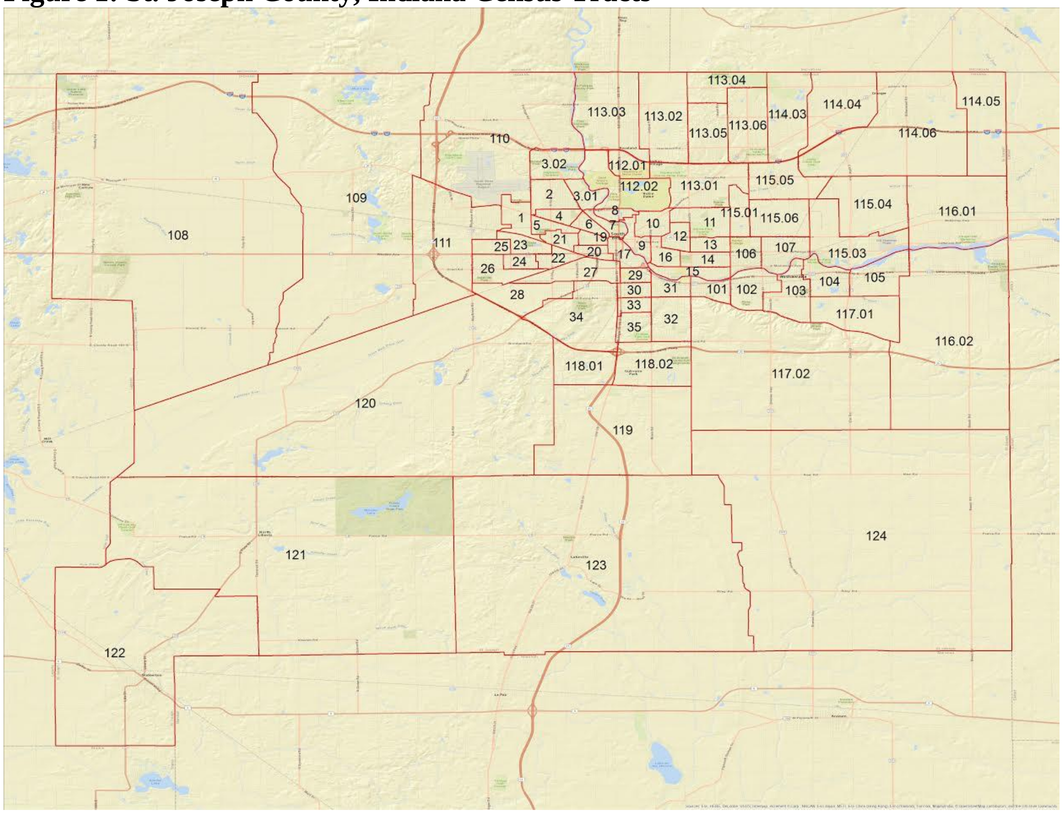
Gender	**Total # of individuals (%)**	**Individuals with EBLL 0 µg/dL (%)**	**Individuals with EBLL 1-4 µg/dL (%)**	**Individuals with EBLL 5-9 µg/dL (%)**	**Individuals with EBLL >= 10 µg/dL (%)**
Female	11806 (50.8)	3066 (52.6)	7710 (50.7)	861 (47.4)	169 (40.1)
Male	11290 (48.5)	2729 (46.8)	7396 (48.7)	922 (50.8)	243 (57.7)
Unknown	160 (0.7)	30 (0.5)	88 (0.6)	33 (1.8)	9 (2.1)
Race	**Frequency**				
American Indian	36 (0.2)	9 (0.2)	22 (0.1)	4 (0.2)	1 (0.2)
Asian/Pacific	142 (0.6)	47 (0.8)	88 (0.6)	5 (0.3)	2 (0.5)
Black	4510 (19.4)	846 (14.5)	3085 (20.3)	473 (26.0)	106 (25.2)
White	9779 (42.0)	2573 (44.2)	6373 (41.9)	688 (37.9)	146 (34.7)
Multiracial	99 (0.4)	20 (0.3)	71 (0.5)	8 (0.4)	0 (0.0)
Other	1364 (5.9)	581 (10.0)	718 (4.7)	59 (3.2)	6 (1.4)
Unknown	7326 (31.5)	1750 (30.0)	4837 (31.8)	579 (31.9)	160 (38.0)
Ethnicity	**Frequency**				
Hispanic	3553 (15.3)	658 (11.3)	2401 (15.8)	405 (22.3)	89 (21.1)
Non-Hispanic	7554 (32.5)	1630 (28.0)	5128 (33.8)	581 (32.0)	215 (51.1)
Unknown	12149 (52.2)	3537 (60.7)	7665 (50.4)	830 (45.7)	117 (27.8)
Pregnancy	**Frequency**				
Yes	8 (0.0)	1 (0.0)	3 (0.0)	0 (0.0)	4 (1.0)
No	22309 (95.9)	5655 (97.1)	14557 (95.8)	1714 (94.4)	383 (91.0)
Unknown	939 (4.0)	169 (2.9)	634 (4.2)	102 (5.6)	34 (8.1)
Medicaid Status	**Frequency**				
Yes	4956 (21.3)	335 (5.8)	3823 (25.2)	611 (33.6)	187 (44.4)
No	8898 (38.3)	2274 (39.0)	5753 (37.9)	734 (40.4)	137 (32.5)
Unknown	9402 (40.4)	3216 (55.2)	5618 (37.0)	471 (25.9)	97 (23.0)

The above table represents the total number of unique individuals and EBLL broken down by demographics. Twelve percent of these individuals are above age 7 and will not be the focus of this report, with the exception of pregnant women. In the section on at risk populations, pregnant women and children under age 7 will be reported. Two case studies of unique individuals in the data set will also be highlighted.

Census Tracts

There are 75 census tracts in SJC. Use Figure 1 for reference.

Figure 1: St. Joseph County, Indiana Census Tracts



From 2005-15 there were 22,335 children under age 7 tested in SJC. Nearly 10.0% of these children had an EBLL >=5 µg/dL. There were seven census tracts (4, 6, 19, 21, 22, 27, 30) in SJC where 20.0% or more of children tested had EBLL >= 5µg/dL (Table 2). Census tract 6 had the highest percentage at 36.4%. Census tract 19 is not far behind at 30.0%. All s of these census tracts have high percentages of homes in poverty and median housing age 1940 or below.

Table 2: Number and Percent of Children Under Age 7 (U7) Tested; EBLL >=5 μg/dL and Risk factor by Census Tract from 2005-2015

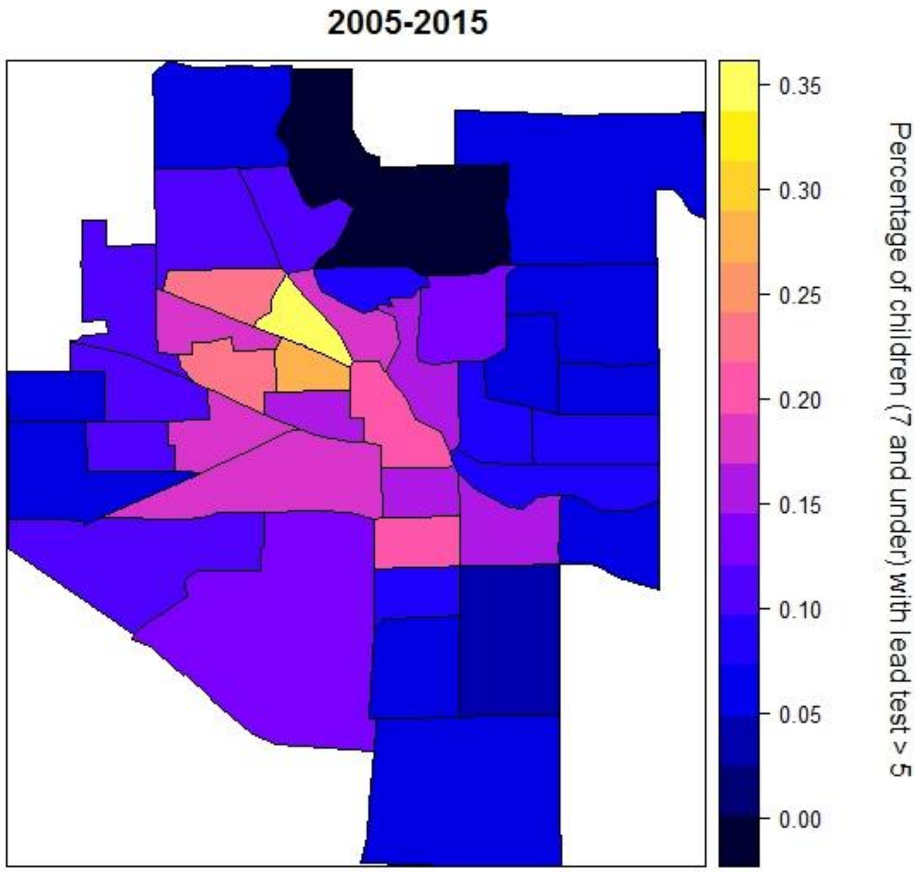
Census tract	Total # of children U7 tested	Total % of children U7 with EBLL >=5mg/dL (n)		Median year of house construction*	% of households in poverty (2015)*
1	339	9.4%	32	1957	19.1
2	408	10.8%	44	1948	38.7
3.01	226	9.7%	22	1950	17.2
3.02	213	4.7%	10	1975	33.4
4	**408**	**23.0%**	**94**	**1940**	**46.3**
5	220	20.9%	46	1946	17.4
6	**368**	**36.4%**	**134**	**1939**	**36.3**
7	153	19.6%	30	1939	8.7
8	116	9.5%	11	1940	7.4
9	79	16.5%	13	1946	11.3
10	290	14.5%	42	1961	34.3
11	446	5.8%	26	1957	18.8
12	132	3.8%	5	1951	2
13	182	4.9%	9	1963	14.4
14	330	9.7%	32	1941	18.5
15	260	7.3%	19	1940	39.9
16	132	6.8%	9	1939	1.9
17	138	16.7%	23	1956	41.7
19	**140**	**30.0%**	**42**	**1939**	**48.6**
20	303	15.8%	48	1953	66.1
21	**204**	**24.5%**	**50**	**1939**	**59.1**
22	**725**	**20.7%**	**150**	**1939**	**23.9**
23	314	10.5%	33	1954	36.8
24	672	12.2%	82	1949	40.2
25	257	4.7%	12	1957	24.1
26	436	5.7%	25	1956	12.6
27	**320**	**20.3%**	**65**	**1939**	**38.4**
28	318	10.4%	33	1959	19.4
29	230	16.5%	38	1958	36.1
30	**250**	**23.2%**	**58**	**1939**	**29.1**
31	382	14.9%	57	1939	32.1
32	285	4.6%	13	1957	6.2
33	291	7.9%	23	1939	28.6
34	565	13.1%	74	1945	30.6
35	416	5.0%	21	1952	27.6
101	206	8.3%	17	1947	25.8
102	370	10.8%	40	1944	23.4
103	454	5.3%	24	1965	8.8
104	187	5.3%	10	1951	13.3
105	135	5.2%	7	1965	2.9

106	255	9.4%	24	1947	23.4
107	238	8.8%	21	1951	14
108	130	4.6%	6	1975	4.5
109	317	2.5%	8	1981	6.5
110	346	2.9%	10	1992	4.9
111	357	8.7%	31	1956	17.3
112.01	147	3.4%	5	1962	24
112.02	10	0.0%	0	1989	4.6
113.01	295	5.8%	17	1976	15.3
113.02	277	2.5%	7	1977	2.4
113.03	357	3.9%	14	1965	7.9
113.04	61	1.6%	1	1978	0.8
113.05	133	3.0%	4	1977	1.5
113.06	83	3.6%	3	1982	1.2
114.03	232	1.7%	4	1987	9.7
114.04	255	2.0%	5	1997	1.7
114.05	125	2.4%	3	1992	2.1
114.06	178	1.1%	2	1985	5.2
115.01	344	7.0%	24	1976	37.7
115.03	70	8.6%	6	1960	3.2
115.04	63	6.3%	4	1984	3.8
115.05	156	3.8%	6	1992	9.1
115.06	370	3.2%	12	1981	8.1
116.01	325	4.3%	14	1986	3.6
116.02	330	6.4%	21	1973	3.1
117.01	254	6.7%	17	1980	19.4
117.02	401	2.5%	10	1985	7
118.01	54	9.3%	5	1984	3.1
118.02	296	4.4%	13	1975	6.1
119	158	2.5%	4	1974	3.1
120	141	5.7%	8	1963	5.8
121	121	7.4%	9	1955	13.7
122	80	10.0%	8	1954	12.6
123	155	7.1%	11	1958	12.6
124	26	3.8%	1	1951	5.6
TOTAL	**19040****				

* Stared data come from the American Community Survey (ACS) 2011-2015 (5-Year Estimates)
** Figure is slightly lower than actual because the census tract for some children's addresses were unable to be accurately determined

Figure 2 visually displays the density of children under 7 years of age with an EBLL >= 5µg/dL. The change in color from dark (0% with an EBLL) to light (35% with an EBLL) represents the density. A quick review reveals that the census tracts located in central SJC have the greatest percentage of children under 7 years of age with an EBLL.

Figure 2: Children Under Age 7 with EBLL >=5 µg/dL by Census Tract, 2005-15



Looking at the most recent year, 2015, there were 923 children under age 5 tested in SJC, with an average testing rate of 6.9% (Table 3). Census Bureau age data is provided in groups of 5 and under, therefore to establish an accurate screening rate we only used testing data for children under 5.

Table 3 breaks down testing rates by census tracts for children under 5. Census tract 21 has a particularly high testing rate at 48.7%, as compared to the other tracts, but no census tract approaches the CDC's recommendation of universal screening of children under 7 years of age. Based on the risk factors of house age and households in poverty, this table could be used to prioritize census tracts for targeted interventions.

Table 3: Screening Rate of Children Under Age 5 (U5); Percentage with EBLL >= 5 μg/dL and Risk Factor by Census Tract for 2015

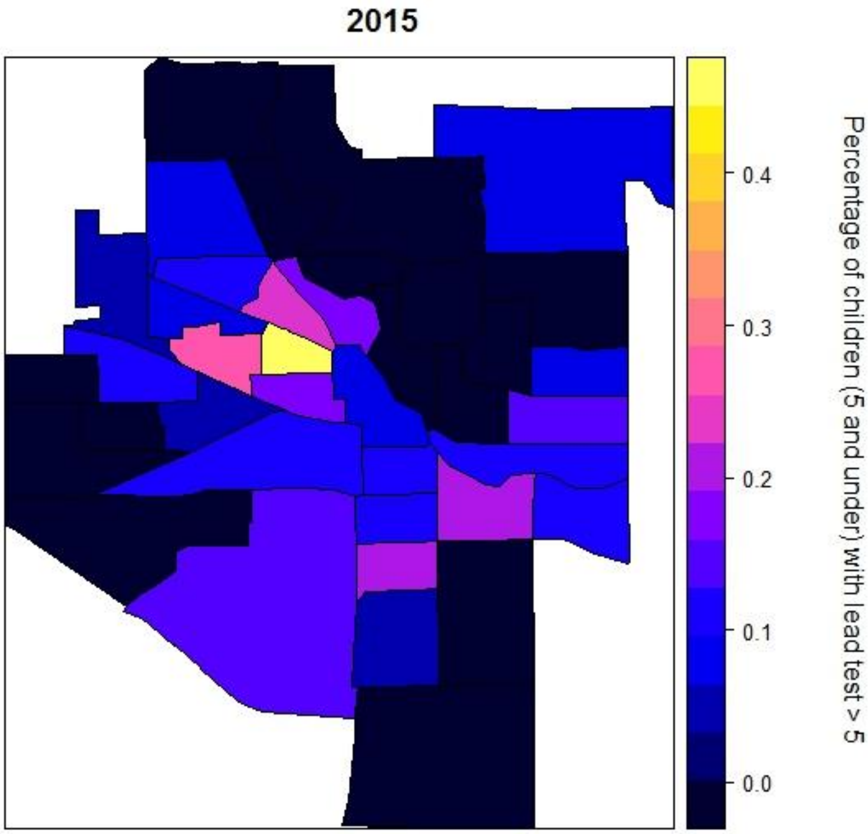
Census tract	# of children U5*	# of tests on children U5	Testing rate 2015	# of children U5 with EBLL of >= 5 μg/dL	% elevated	Median year of house construction*	% of Households in Poverty (2015)*
1	167	19	11.4%	1	5.3%	1957	19.1
2	306	27	8.8%	2	7.4%	1948	38.7
3.01	268	10	3.7%	0	0.0%	1950	17.2
3.02	267	10	3.8%	0	0.0%	1975	33.4
4	**265**	**20**	**7.6%**	**2**	**10.0%**	**1940**	**46.3**
5	101	20	19.8%	2	10.0%	1946	17.4
6	**246**	**20**	**8.1%**	**5**	**25.0%**	**1939**	**36.3**
7	82	6	7.3%	1	16.6%	1939	8.7
8	102	4	3.9%	0	0.0%	1940	7.4
9	12	4	33.3%	0	0.0%	1946	11.3
10	224	12	5.4%	0	0.0%	1961	34.3
11	498	16	3.2%	0	0.0%	1957	18.8
12	200	8	4.0%	0	0.0%	1951	2.0
13	157	12	7.6%	1	8.3%	1963	14.4
14	144	14	9.7%	2	14.3%	1941	18.5
15	103	8	7.8%	1	12.5%	1940	39.9
16	141	9	6.4%	0	0.0%	1939	1.9
17	48	9	18.8%	1	11.1%	1956	41.7
19	**119**	**9**	**7.5%**	**4**	**44.4%**	**1939**	**48.6**
20	154	18	11.7%	3	16.7%	1953	66.1
21	**39**	**19**	**48.7%**	**5**	**26.3%**	**1939**	**59.1**
22	240	42	17.5%	2	4.8%	1939	23.9
23	110	8	7.3%	1	12.5%	1954	36.8
24	182	36	19.8%	0	0.0%	1949	40.2
25	234	11	4.7%	0	0.0%	1957	24.1
26	293	15	5.1%	0	0.0%	1956	12.6
27	105	17	16.2%	2	11.8%	1939	38.4
28	276	22	8.0%	0	0.0%	1959	19.4
29	73	18	24.7%	2	11.1%	1958	36.1
30	**138**	**9**	**6.5%**	**1**	**11.1%**	**1939**	**29.1**
31	368	19	5.2%	4	21.1%	1939	32.1
32	416	15	3.6%	0	0.0%	1957	6.2
33	381	14	3.7%	3	21.4%	1939	28.6
34	446	36	8.1%	5	13.9%	1945	30.6
35	239	16	6.7%	1	6.3%	1952	27.6
101	226	8	3.5%	1	12.5%	1947	25.8
102	296	10	3.4%	0	0.0%	1944	23.4
103	640	21	3.3%	0	0.0%	1965	8.8
104	318	6	1.9%	0	0.0%	1951	13.3
105	166	3	1.8%	0	0.0%	1965	2.9
106	163	16	9.8%	2	12.5%	1947	23.4
107	223	15	6.7%	0	0.0%	1951	14.0
108	318	7	2.2%	0	0.0%	1975	4.5
109	430	19	4.4%	1	5.3%	1981	6.5
110	484	24	5.0%	0	0.0%	1992	4.9
111	246	19	7.7%	3	15.8%	1956	17.3
112.01	90	5	5.6%	0	0.0%	1962	24.0
112.02	12	0	0.00%	0	NA	1989	4.6
113.01	235	13	5.5%	1	7.7%	1976	15.3
113.02	541	15	2.8%	0	0.0%	1977	2.4
113.03	287	13	4.5%	1	7.7%	1965	7.9
113.04	87	1	1.2%	0	0.0%	1978	0.8
113.05	279	10	3.6%	0	0.0%	1977	1.5

113.06	78	3	3.9%	0	0.0%	1982	1.2
114.03	433	4	0.9%	0	0.0%	1987	9.7
114.04	409	3	0.7%	0	0.0%	1997	1.7
114.05	179	8	4.5%	0	0.0%	1992	2.1
114.06	266	5	1.9%	0	0.0%	1985	5.2
115.01	221	11	5.0%	0	0.0%	1976	37.7
115.03	90	3	3.3%	0	0.0%	1960	3.2
115.04	52	2	3.9%	0	0.0%	1984	3.8
115.05	177	6	3.4%	0	0.0%	1992	9.1
115.06	284	12	4.2%	0	0.0%	1981	8.1
116.01	399	15	3.8%	0	0.0%	1986	3.6
116.02	327	9	2.8%	1	11.1%	1973	3.1
117.01	250	11	4.4%	3	27.3%	1980	19.4
117.02	510	23	4.5%	0	0.0%	1985	7.0
118.01	29	0	0.00%	0	0.0%	1984	3.1
118.02	271	23	8.5%	0	0.0%	1975	6.1
119	250	9	3.6%	0	0.0%	1974	3.1
120	144	8	5.6%	0	0.0%	1963	5.8
121	324	1	0.3%	0	0.0%	1955	13.7
122	311	6	1.9%	0	0.0%	1954	12.6
123	142	3	2.1%	1	33.3%	1958	12.6
124	149	1	0.7%	0	0.0%	1951	5.6
TOTAL	**17480**	**923**					
AVE			**6.82%**				

* Stared data come from the American Community Survey (ACS) 2011-2015 (5-Year Estimates)

Figure 3 below highlights testing for children under 5 years old by census tract for 2015 only. While the map may suggest lower percentages of children with an EBLL >=5 µg/dL, 2015 was also the year that had the lowest number of unique individuals screened (see Table 8).

Figure 3: Children Under 5 With EBLL >=5 µg/dL by Census Tract for 2015



Screenings

Unique Individuals Screened

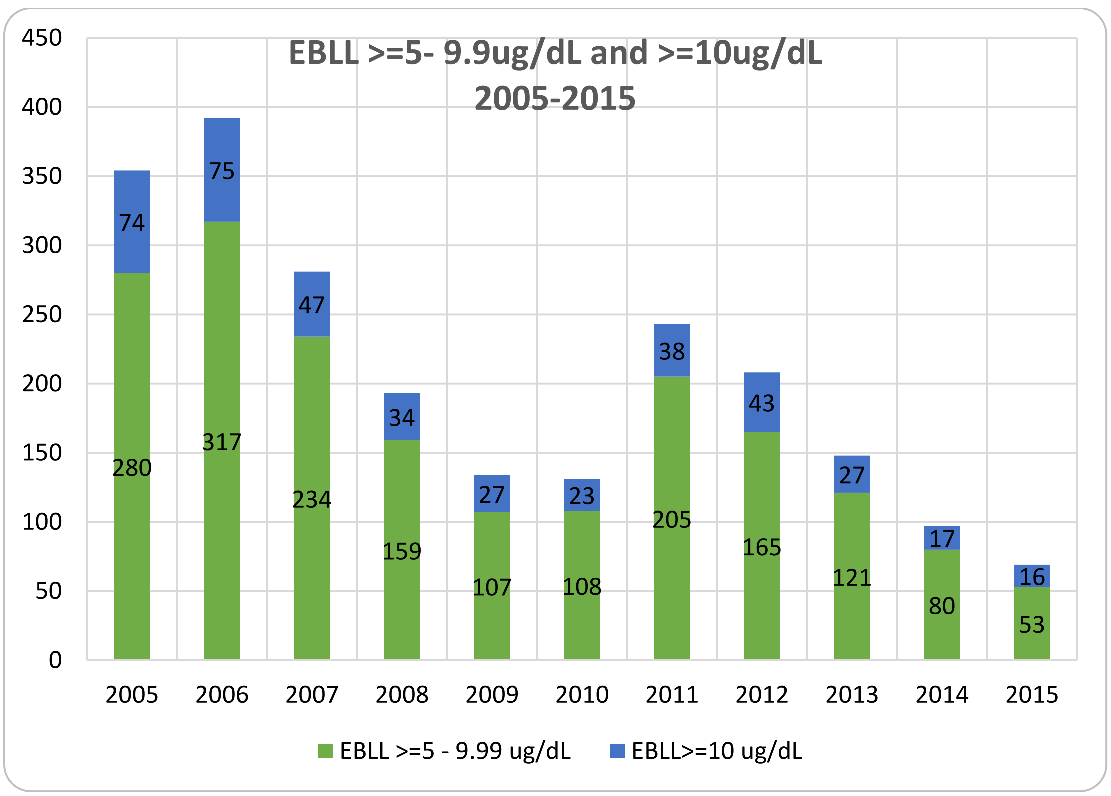
From 2005 – 2015, there were 23,256 unique individuals screened for lead which resulted in 28,467 tests. There were 1.23 tests per unique individual. Of those 23,256 unique individuals screened for lead, 75.0% had an EBLL > 0.0µg/dL. Table 4 shows two important pieces of information (1) the number of unique individuals screened and the average lead level by age group and (2) the number of unique individuals with an EBLL > 0.0 µg/dL and the average lead level by age group. Figure 4 provides a visual representation of unique individuals with EBLL >= 5 – 9.9 µg/dL and >=10 µg/dL.

Table 4. Average EBLL for Unique Individuals

Age (years)	Unique Individuals	Average Pb level (sd*) for all individuals	Maximum Pb Level	Unique Individuals with EBLL > 0	Average Pb Level (sd*) for individuals with EBLL
0-1	2849	1.5 (1.9)	37	1960	2.2 (1.9)
1-1.99	9200	2.2 (2.6)	54	6843	2.9 (2.6)
2-2.99	2943	2.6 (2.8)	27	2327	3.2 (2.7)
3-3.99	1481	2.5 (3.0)	37	1191	3.2 (3.0)
4-4.99	2053	2.3 (2.4)	35	1679	2.8 (2.4)
5-5.99	1144	2.2 (2.3)	27	946	2.7 (2.3)
6-6.99	511	2.0 (2.5)	26	386	2.7 (2.5)
7-18	1225	1.5 (2.2)	23	708	2.6 (2.3)
18-45	1266	2.3 (3.7)	56	910	3.2 (4.1)
>45	584	3.2 (5.3)	53	481	3.9 (5.7)
TOTAL	**23256**			**17431**	

* sd = standard deviation

Figure 4. Unique Individuals with EBLL >= 5 – 9.9 µg/dL and >=10 µg/dL



Health Care Providers

A review of the initial dataset included 1,043 health care providers. Health care providers were defined as an individual health care professional or health care facility. After correcting for duplicate and misspelled provider names, there were approximately 800 health care providers in the dataset. Table 5 below shows the top ten providers of lead screening in St. Joseph County.

Table 5. Top Ten Health Care Providers

	Frequency of Tests	Percent of ALL Providers
Indiana Health Clinic- South Bend	5721	19.9%
LaPorte Medical Group	1296	4.5%
Navarre Pediatric Group	1012	3.5%
St. Joseph County WIC Program	635	2.2%
Felger, Thomas (SJCHD)	565	2.0%
Toper, Sibel	545	1.9%
Toper, Ziya	526	1.8%
Memorial Health Center	491	1.7%
Dunham, Timothy	413	1.4%
Barrett, Daniel	372	1.3%
TOTAL TESTS for TOP TEN PROVIDERS	**11576**	
TOTAL TESTS for ALL PROVIDERS	**28764**	

Laboratory Providers

A review of the initial dataset included 59 laboratory providers. After correcting for duplicate and misspelled provider names, there were 53 laboratory providers in the dataset. Table 6 shows the top ten providers of lead processing for St. Joseph County residents.

Table 6. Top Ten Laboratory Providers

	Frequency of Tests	Percent of ALL Providers
South Bend Medical Foundation	13631	47.4%
LabCorp Dublin	4646	16.2%
Tamarac Medical	4534	15.8%
Medtox Laboratories	1868	6.5%
LaPorte Medical Group	1297	4.5%
Navarre Medical Group	1058	3.7%
Medtox Memorial Hospital	338	1.2%

Indiana State Health Department	331	1.2%
Arup Laboratories	221	0.8%
Unknown	180	0.6%
TOTAL TESTS for TOP TEN LABORATORIES	**28104**	
TOTAL TESTS for ALL LABORATORIES	**28764**	

Test Reason

Table 7 shows the reason for lead testing for all lead tests (N = 28,467). Routine and Unknown accounted for 98.9% of test reasons documented. This is notable for two reasons: (1) creates difficulty in trying to ascertain individual's EBLL status when multiple results exist and (2) demonstrates poor data collection procedures.

Table 7. Test Reason for All Tests by Age

Test reason		**Age (years)**					
	< 1	**1-1.99**	**2-6.99**	**7-17.99**	**18-44.99**	**>= 45**	**TOTAL**
Confirmatory	14	31	80	10	1	1	**137**
Follow-up	0	23	90	10	4	10	**137**
Poisoning symptoms	1	3	3	0	3	8	**18**
Routine	1721	5265	5443	703	801	202	**14135**
Unknown	971	4549	6732	647	667	474	**14040**
TOTAL	**2707**	**9871**	**12348**	**1370**	**1476**	**695**	**28467**

At Risk Populations Screening and EBLL

Pregnant Women

The dataset contained only 8 individuals who were reported pregnant. Half of those were <2 years of age or reported gender as male and were therefore discarded. Four women remained between the ages of 17 and 39 years. Of the 4 pregnant women in the database, 3 had actionable lead test results at 10, 23, and 40µg/dL. The fourth woman had a result of 1µg/dL. There were 147 women between the ages of 16 and 41 with an unknown pregnancy status.

Children <7 Years of Age

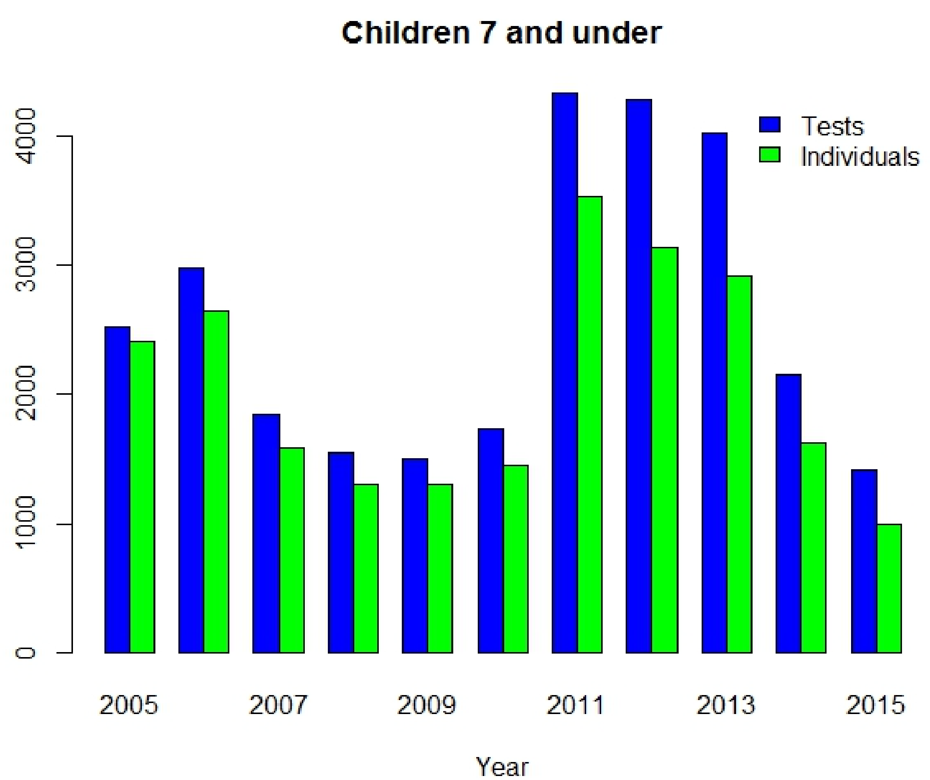
Of the 23,256 unique individuals screened, 85.7% (n=19,941) were < 7 years of age (Table 8). Of those < 7 years, 8.0% had an EBLL >= 5 – 9.9µg/dL and 1.7% had an EBLL >= 10 µg/dL.

Table 8. EBLL in Children Under Age 7 in St. Joseph County by Year, 2005-15

Year	Total children U7 tested	EBLL 5 – 9.9 µg/dL	EBLL>=10 µg/dL
2005	2134	261	67
2006	2213	259	60
2007	1230	189	33
2008	1069	132	24
2009	1070	83	18
2010	1279	97	20
2011	3229	190	27
2012	2824	148	33
2013	2590	109	20
2014	1425	71	15
2015	878	50	16
TOTAL	**19941**	**1589**	**333**

Figure 5 shows the total number of tests and the total number of unique individuals < 7 years of age screened each year. In the peak year of 2011, the South Bend Housing Authority received a Housing and Urban Development (HUD) grant that included monies to boost screenings. The funding ended in 2014 which signaled the significant decline in screenings.

Figure 5. Total Tests and Unique Individuals Under Age 7 Screened, 2005-15



Implications for Case Management

For 2005 -2015, there were 19,941 children under age 7 who were screened for lead. As shown in Table 8 above, 1,589 and 333 unique individuals had an EBLL 5 – 9.9 µg/dL or >= 10µg/dL, respectively, which represents an approximate 5:1 ratio. There were also 3,315 individuals age 7 and above who were screened for lead of which 292 unique individuals had an EBLL >= 5 µg/dL. Although this group may be at lower risk for lead exposure, pregnancy status is unknown for females and follow up would be recommended. As previously stated, the CDC lowered the lead reference level to 5 µg/dL in 2012. At this time, given budget restrictions, the SJCHD only initiates case management on individuals with an EBLL >= 10µg/dL.

Individual Case Studies

Two unique cases were selected from the dataset to highlight to illustrate some of the challenges associated with interpreting the data.

Case 1

This individual is a Hispanic male who was 3.8 years of age and living in census tract 30 at his first screening. This individual had the highest volume of tests in the dataset and all had an EBLL above 5µg/dL. Over the course of 38 months he had 23 venous blood draws performed by the same physician and analyzed at one lab. Test results ranged from 8 – 51µg/dL (Table 9).

Table 9: Case study 1: Date, Result and Reason of Lead Test

Date of test	Pb result (µg/dL)	Recorded reason for test
21-Feb-11	8.0	Routine
13-May-11	11.0	Unknown
15-Jul-11	11.0	Unknown
8-Sep-11	12.0	Unknown
3-Dec-11	26.0	Unknown
17-Dec-11	16.0	Unknown
30-Dec-11	16.0	Unknown
16-Jan-12	15.0	Unknown
22-Feb-12	12.0	Unknown
24-Mar-12	49.0	Unknown
28-Mar-12	49.0	Follow up
14-Apr-12	28.0	Unknown
26-Apr-12	51.0	Unknown

10-May-12	11.0	Unknown
29-May-12	13.0	Follow up
14-Jun-12	22.0	Unknown
13-Jul-12	22.0	Unknown
17-Sep-12	22.0	Unknown
11-Jan-13	15.0	Unknown
13-May-13	13.0	Unknown
13-Sep-13	10.6	Unknown
21-Jan-14	9.0	Unknown
23-Apr-14	9.0	Follow up

Case 2

This individual is a 39-year-old, non-Hispanic, female living in census tract 32 at the time of the initial test. She had 5 capillary tests over the course of 19 months. She had the highest recorded EBLL at 123 µg/dL in the dataset. This is likely an error in recording the data as a reading that high is unlikely, and not even possible if a LeadCare II machine was used, the most commonly used testing machine (Magellan Diagnostics, 2015). Errors in lead level reporting can skew the data set.

Table 10: Case Study 2: Date, Result and Reason of Lead Test

Provider	Date of test	Pb result (µg/dL)	Sample type	Recorded reason for test
TEST MD, LABWORKSXXX	16-Mar-11	12.0	Capillary	Routine
TEST MD, LABWORKSXXX	10-May-11	1.0	Capillary	Routine
TEST MD, LABWORKSXX	13-Jun-11	123.0	Capillary	Routine
TEST MD, LABWORKSXX	29-Feb-12	1.0	Capillary	Routine
TEST MD, LABWORKSXX	8-Oct-12	10.0	Capillary	Routine

CONCLUSION

There were several major findings. First, lead screening rates in SJC are very low at less than 10.0%. Second, children under 7 years of age represented 87.6% of individuals screened for lead. Third, seven census tracts had at least 20% of children under 7 years of age screened with an EBLL >= 5µg/dL; census tract 4, 6, 19, 21, 22, 27 and 30. Census tract 6 was the highest at 36.4%. Fourth, data collection is very poor resulting in over one-third to one-half of all variables indicating a null, unknown or data entry errors. Fifth, of the 19,941 <7 year olds screened, there were 333

EBLL >= 10µg/dL and 1,589 EBLL 5 – 9.9 µg/dL. This suggests about a 1:5 ratio resulting in case management implications. Finally, pregnant women are underrepresented in the dataset with just four women accurately identified as pregnant.

The analysis brought to the surface the need to re-focus efforts on children under 7 and pregnant and lactating women. The CDC guidelines for screening and management of these populations are well established. Efforts to increase awareness, affect policy and improve lead screening and management are essential.

RECOMMENDATIONS

1. Improve data collection
    a. Conduct an in-depth analysis to understand how data is collected and processed; seek efficiencies, standardize and accuracy
    b. Meet with key stakeholders responsible for the majority of data collection
    c. Compile and share data with key stakeholders regularly
2. Improve screening rates significantly
    a. Meet with key stakeholders to understand barriers to screening and to build sustainable policies and procedures to ensure screening for children < 7 years of age
    b. Publicize that children <7 years of age enrolled in Medicaid are eligible to receive free testing
    c. Promote utilization of Lead Care analyzers at high volume providers
3. Implement the CDC guidelines to case manage EBLLs >5µg/dL
    a. Cross train employees to perform case management
    b. Seek funding to support additional personnel required
4. Implement the CDC guidelines for screening and management for pregnant and lactating women who have been exposed to lead
    a. Meet with key stakeholders to discuss guidelines and data
    b. Create plan to raise awareness regarding CDC guidelines

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