Summary of Findings from the North Carolina ABLES Program for 2015

North Carolina Division of Public Health
Occupational and Environmental Epidemiology Branch

More information about ABLES is located at:
http://epi.publichealth.nc.gov/oee/programs/ables.html

Summary

In 2015, the North Carolina Adult Blood Lead Epidemiology Surveillance (NC ABLES) Program received 7,983 blood lead reports representing 5,329 adults aged 16 years and older. 653 (12.3%) of these adults had an elevated blood lead level ≥ 10 µg/dL (EBLL) and most exposure was occupational. Among adults with EBLLs, 38 (5.8%) persons exceeded the OSHA lead standard's health protection goal of 40 µg/dL for the prevention of adverse health effects for most workers. The prevalence of BLLs ≥ 10 µg/dL in 2015 was 14.49 persons per 100,000 employed persons which is higher than the five-year average prevalence rate of 10.12 persons per 100,000 employed persons. The major sources of occupational exposure remain as Primary Battery Manufacturing (63.5%); Iron and Steel Mills (11.6%); and Nonferrous Metal (Except Copper and Aluminum) Rolling, Drawing, and Extruding (4.9%). For those exposed to lead by non-occupational means, the primary exposure sources were from shooting firearms (33.3%) and retained bullets (22.2%). Individuals were exposed to lead in 36 North Carolina counties including Forsyth and Caldwell counties which had the highest numbers of individuals with EBLLs.

Background

The National Institute for Occupational Safety and Health (NIOSH) established the ABLES program in 1987 to identify and decrease the number of adults aged 16 years and older with EBLLs.[1] North Carolina started a state-based program in 1994 and enacted a mandatory reporting law, 10A NCAC 41C .0701-.0703, which requires all commercial labs to report adult blood leads to the NC ABLES program. Results are compiled every year and shared with NIOSH. The NC ABLES program periodically documents the rates of EBLLs in order to see trends over time and identify outreach priorities. The current objective of the program follows the Healthy People 2020, Objective 7; to reduce EBLLs from work exposure of greater than or equal to 10 µg/dL in adults aged 16 years and older.[2] Over the past 20 years, the ABLES program has documented a 54% decrease in the prevalence of BLLs ≥ 25 µg/dL.[1]

Individuals can be exposed to lead in both occupational and non-occupational settings through inhalation, ingestion, or, in rare cases, skin absorption of lead dust or fumes. Occupational lead exposure accounts for approximately 95% of all cases of EBLLs.[3] Several industries work with lead-based products including artistry, battery production, construction, mining, and plumbing. If proper personal hygiene is not performed, workers may bring lead home unintentionally on clothes, skin, or shoes exposing their family members. Sources of non-occupational exposure include hobbies such as going to firing ranges, making homemade fishing weights, and ceramic

making. Cooking from leaded cookware and drinking liquids containing lead, such as moonshine, can also play a role in exposure.

Health effects from acute lead exposure are well documented and, in general, the number and severity of symptoms worsen with increasing BLLs. With mild lead toxicity, symptoms tend to be non-specific and may include mild fatigue, irritability, and sleep disturbances; moderate toxicity may produce headaches, more profound fatigue, muscle aches and irritability, mental status changes, and gastrointestinal changes; and severe toxicity usually results in a medical emergency and may produce digestive disorders, peripheral neuropathy and encephalopathy.

Research indicates that health effects are also occurring at very low levels of exposure (≤ 10 µg/dL) to include tremors, decrease in kidney function, increased blood pressure, and fertility and other reproductive issues. Children exposed to low levels of lead are at higher risk than adults since they are still developing and the body can absorb lead more easily.[4] The brain and nervous system can both be affected leading to behavior and learning problems, stunted development, and anemia.[5] As stipulated by the OSHA Lead General Industry Standard 29 CFR 1910.1025 and the OSHA Lead in Construction Standard 29 CFR 1926.62, industries are required to have protocols in place to protect workers from lead.[6] The Environmental Protection Agency (EPA) publishes safe practices for citizens who may come in contact with lead.[5]

To try and prevent occupational lead exposure in North Carolina, individuals with BLLs ≥ 10 µg/dL, receive public health education by mail and persons with BLLs ≥ 40 µg/dL receive phone interviews on how to reduce exposure. A state industrial hygienist also calls the employer when employee blood leads reach 40 µg/dL and above to discuss the exposure controls necessary to reduce occupational lead exposure. The industrial hygienist may also suggest conducting a site visit. NC ABLES refers individual cases of very high blood leads and noncompliant employers to NC OSHA.[7]

Methods

Reports of BLLs were received electronically, by mail, and fax from commercial laboratories. Data were analyzed using SAS 9.4 and Microsoft Excel. Incidence and prevalence rates were calculated using the methods listed in the Council of State and Territorial Epidemiologists (CSTE) Occupational Health Indicators: A Guide for Tracking Occupational Health Conditions and Their Determinants.[3] Total employment was determined from the U.S. Bureau of Labor Statistics for the respective years in order to calculate prevalence and incidence.[8]

Results

NC ABLES received a total of 7,983 blood lead reports from commercial laboratories in 2015. The 7,983 reports represented 5,329 individuals from across the state. There was an increase in the number of reports submitted in 2014 and 2015 compared to earlier years due to one industry in North Carolina deciding to conduct routine blood lead testing on a monthly basis (Figure 1). Of all adults tested, 653 (12.3%) had BLLs ≥ 10 µg/dL (Table 1). For those cases where exposure source was known, occupational exposure accounted for 99% of adults tested. Among persons with EBLLs, 38 (5.8%) had levels at or above 40 µg/dL (Table 1). The range of all of

the blood lead reports was 1 µg/dL to 75 µg/dL with the average BLL calculated at 4.2 µg/dL and the median at 2 µg/dL for all adults tested.

The age group which had the highest number of EBLLs was 45-54 (Table 2). The majority of adults tested in 2015 were male (72.6%). Males also accounted for a much higher proportion (94.6%) of those with EBLLs vs females (5.4%.) (Table 2). The prevalence and incidence rates of BLLs ≥ 10 µg/dL were 14.49 and 6.7 persons per 100,000 employed persons, respectively (Figure 3). The prevalence of blood leads greater than or equal to 10 has substantially increased when compared to the average for the last five years combined, 10.12 persons per 100,000 employed persons. For BLLs ≥ 40 µg/dL, the prevalence rate was 0.84 per 100,000 employed persons and the incidence rate was 0.47 per 100,000 employed persons (Table 4). The incidence of BLLs ≥ 10 µg/dL, prevalence of BLLs ≥ 40 µg/dL, and incidence of BLLs ≥ 40 µg/dL have not differed greatly when compared to the respective five-year averages.

Primary Battery Manufacturing was the industry sector which had the highest number of individuals with EBLLs. This industry, however, did not have any BLLs ≥ 40 µg/dL. The industry with the most BLLs ≥ 40 µg/dL reported (68%) was Nonferrous Metal (Except Copper and Aluminum) Rolling, Drawing, and Extruding (Table 3). Non-occupational exposure was rare. 15 adults had EBLLs with known home or recreational lead exposures. Almost a third of these adults were exposed to lead through shooting firearms. Only one individual had an EBLL over 40 µg/dL and it was due to a retained bullet from previous military experience (Table 4). The same individual also had the highest BLL out of all of the reports for 2015 which was 75 µg/dL. Counties with the highest number of reports of EBLLs were Forsyth (80.1%), Caldwell (3.9%), Gaston (1.3%), and Mecklenburg (1.3%) (Table 5). 576 adults were tested in Forsyth County and all of those adults had occupational exposure to lead. 371 (64%) of those adults had EBLLs. This is due to the presence of a large lead-acid battery manufacturer located in Forsyth County.

Conclusions

North Carolina's prevalence rate of BLLs ≥ 10 µg/dL was 14.49 per 100,000 employed individuals in 2015. This rate falls above the North Carolina average prevalence, but below the national prevalence rate which is 22.5 per 100,000 employed individuals.[9] Primary Battery Manufacturing was the industry that accounted for most of the occupational exposure in North Carolina and is among the top industries for lead exposure in the United States.[1] Of the non-occupational exposures identified, the activity that accounted for the majority of exposures was firing weapons.

Priorities for outreach include targeting battery manufacturing industries and increasing awareness of lead exposure in firing ranges. Continuing outreach in primary battery manufacturing industries will inform employees and employers on how to reduce exposure and blood leads. Information should include developments in science regarding chronic, low-level lead exposure and the resulting health effects. Lead can inadvertently be taken home by workers, so outreach should include information on the dangers of take-home lead exposure and the impact it can have on family members and friends.

If firing ranges are not properly ventilated, target shooters can unknowingly be exposed to lead. Appropriate outreach to range operators should include information about checking ventilation systems every three months to prevent exposure to lead dust and fumes during firearm use.[10]

Tables and Figures

Table 1. Distribution of Highest Blood Lead Levels Among Adults Tested in NC: 2015

BLL (µg/dL)	Exposure Source							
	All		Occupational		Non-Occupational		Unknown	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
<10	4676	87.8%	1704	76.8%	9	32.1%	2963	96.17%
10-24	560	10.5%	442	19.9%	17	60.7%	101	3.28%
25-39	55	1.0%	47	2.1%	0	0.0%	8	0.26%
40-49	21	0.4%	16	0.7%	0	0.0%	5	0.16%
50-59	15	0.3%	11	0.5%	1	3.6%	3	0.10%
≥ 60	2	0.0%	0	0.0%	1	3.6%	1	0.03%
Total	**5329**	**100%**	**2220**	**100%**	**28**	**100%**	**3081**	**100%**

Table 2. Distribution of Age and Sex Among Adults Tested for Blood Lead in NC: 2015

Characteristic	BLL (µg/dL)					
	All		≥ 10		≥ 40	
	Count	Percent	Count	Percent	Count	Percent
Age* (Years)						
16-17	47	0.9%	0	0.0%	0	0.0%
18-24	455	8.6%	32	4.9%	2	5.3%
25-34	1052	19.9%	143	22.0%	12	31.6%
35-44	962	18.2%	122	18.8%	10	26.3%
45-54	1081	20.5%	173	26.6%	9	23.7%
55-64	949	18.0%	141	21.7%	5	13.1%
65+	735	13.9%	39	6.0%	0	0.0%
Total	**5281**	**100%**	**650**	**100%**	**38**	**100%**
Sex†						
Male	3849	72.6%	618	94.6%	37	97.4%
Female	1450	27.4%	35	5.4%	1	2.6%
Total	**5299**	**100%**	**653**	**100%**	**38**	**100%**

*Age was unknown for 48 individuals

†Sex was unknown for 30 individuals

Table 3. Distribution of Occupational Lead Exposure* in NC: 2015

NAICS Code†	Industry Title	BLL (µg/dL)					
		All		≥ 10		≥ 40	
		Count	Percent	Count	Percent	Count	Percent
Occupational Exposure							
23	Construction	1	0.1%	1	0.2%	0	0.0%
237310	Highway, Street, and Bridge Construction	18	2.2%	16	3.3%	3	12.0%
238120	Structural Steel and Precast Concrete Contractors	1	0.1%	1	0.2%	0	0.0%
238210	Electrical Contractors and Other Wiring Installation Contractors	1	0.1%	1	0.2%	0	0.0%
238220	Plumbing, Heating, and Air-Conditioning Contractors	3	0.4%	3	0.6%	0	0.0%
238310	Drywall and Insulation Contractors	1	0.1%	1	0.2%	0	0.0%
238320	Painting and Wall Covering Contractors	18	2.2%	18	3.7%	0	0.0%
238910	Site Preparation Contractors	2	0.2%	0	0.0%	0	0.0%
238990	All Other Specialty Trade Contractors	3	0.4%	0	0.0%	0	0.0%
314999	All Other Miscellaneous Textile Product Mills	10	1.2%	0	0.0%	0	0.0%
325188	All Other Basic Inorganic Chemical Manufacturing	2	0.2%	2	0.4%	1	4.0%
325211	Plastics Material and Resin Manufacturing	16	1.9%	1	0.2%	0	0.0%
326199	All Other Plastics Manufacturing	4	0.5%	1	0.2%	0	0.0%
327211	Flat Glass Manufacturing	2	0.2%	2	0.4%	0	0.0%
327215	Glass Product Manufacturing Made of Purchased Glass	1	0.1%	1	0.2%	0	0.0%
331111	Iron and Steel Mills	96	11.6%	5	1.0%	0	0.0%
331491	Nonferrous Metal (except Copper and Aluminum) Rolling, Drawing, and Extruding	41	4.9%	36	7.5%	17	68.0%
332116	Metal Stamping	3	0.4%	3	0.6%	1	4.0%
332312	Fabricated Structural Metal Manufacturing	22	2.7%	17	3.5%	2	8.0%
332322	Sheet Metal Work Manufacturing	1	0.1%	1	0.2%	0	0.0%
332510	Hardware Manufacturing	2	0.2%	2	0.4%	0	0.0%
332992	Small Arms Ammunition Manufacturing	1	0.1%	1	0.2%	0	0.0%
332994	Small Arms, Ordnance, and Ordnance Accessories Manufacturing	1	0.1%	0	0.0%	0	0.0%

NAICS Code†	Industry Title	BLL (µg/dL)					
		All		≥ 10		≥ 40	
		Count	Percent	Count	Percent	Count	Percent
Occupational Exposure (Continued)							
332999	All Other Miscellaneous Fabricated Metal Product Manufacturing	3	0.4%	2	0.4%	0	0.0%
335911	Storage Battery Manufacturing	3	0.4%	0	0.0%	0	0.0%
335912	Primary Battery Manufacturing	527	63.5%	326	67.6%	0	0.0%
339920	Sporting and Athletic Goods Manufacturing	1	0.1%	1	0.2%	0	0.0%
424210	Drugs and Druggists' Sundries Merchant Wholesalers	1	0.1%	1	0.2%	0	0.0%
486910	Pipeline Transportation of Refined Petroleum Products	1	0.1%	0	0.0%	0	0.0%
541330	Engineering Services	1	0.1%	0	0.0%	0	0.0%
56133	Professional Employer Organizations	1	0.1%	0	0.0%	0	0.0%
561720	Janitorial Services	1	0.1%	1	0.2%	0	0.0%
562211	Hazardous Waste Treatment and Disposal	2	0.2%	1	0.2%	0	0.0%
562910	Remediation Services	5	0.6%	5	1.0%	0	0.0%
562920	Materials Recovery Facilities	1	0.1%	1	0.2%	0	0.0%
611310	Colleges, Universities, and Professional Schools	1	0.1%	1	0.2%	0	0.0%
611699	All Other Miscellaneous Schools and Instruction	2	0.2%	2	0.4%	0	0.0%
713990	All Other Amusement and Recreation Industries	19	2.3%	18	3.7%	0	0.0%
811113	Automotive Transmission Repair	1	0.1%	1	0.2%	0	0.0%
811310	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	1	0.1%	1	0.2%	1	4.0%
812199	Other Personal Care Services	2	0.2%	2	0.4%	0	0.0%
92119	Other General Government Support	1	0.1%	1	0.2%	0	0.0%
922120	Other Justice, Public Order, and Safety Activities	3	0.4%	3	0.6%	0	0.0%
928110	National Security	3	0.4%	2	0.4%	0	0.0%
	Total Exposed	**830**	**100%**	**482**	**100%**	**25**	**100%**

*NAICS Code unknown for 1,390 individuals

†North American Industry Classification System

Table 4. Distribution of Non-Occupational Lead Exposure* in NC: 2015

Exposure Source	BLL (µg/dL)					
	All		≥ 10		≥ 40	
	Count	Percent	Count	Percent	Count	Percent
Non-Occupational Exposure						
Shooting Firearms	6	33.3%	4	26.7%	0	0.0%
Casting (e.g. bullets, fishing weights)	2	11.1%	2	13.3%	0	0.0%
Retained Bullets	4	22.2%	4	26.7%	1	100%
Eating from Leaded Cookware	1	5.6%	0	0.0%	0	0.0%
Multiple (Eating from Leaded Cookware & Eating Food Containing Lead)	1	5.6%	1	6.7%	0	0.0%
Drinking Liquids Containing Lead	1	5.6%	1	6.7%	0	0.0%
Retired (Possible Former Lead Worker)	3	16.7%	3	20.0%	0	0.0%
Total Exposed	**18**	**100%**	**15**	**100%**	**1**	**100%**

*Exposure Source unknown for 10 individuals

Table 5. Distribution of County of Exposure* Among Adults Tested for Blood Lead in NC: 2015

County	BLL (µg/dL)					
	All		≥ 10		≥ 40	
	Count	Percent	Count	Percent	Count	Percent
Caldwell	22	2.7%	18	3.9%	3	13.6%
Forsyth	576	71.6%	371	80.5%	18	81.8%
Gaston	9	1.1%	6	1.3%	0	0%
Iredell	6	0.7%	5	1.1%	0	0%
Mecklenburg	19	2.4%	6	1.3%	1	4.5%
Onslow	5	0.6%	5	1.1%	0	0%
Wake	6	0.7%	5	1.1%	0	0%
Other Counties†	162	20.1%	45	9.8%	0	0%
Total	**805**	**100%**	**461**	**100%**	**22**	**100%**

*County of exposure was unknown for 4,524 individuals

†29 Other Counties had less than 5 individuals with elevated blood lead levels each

Figure 1. Total Number of Reports Received in NC: 2011 – 2015

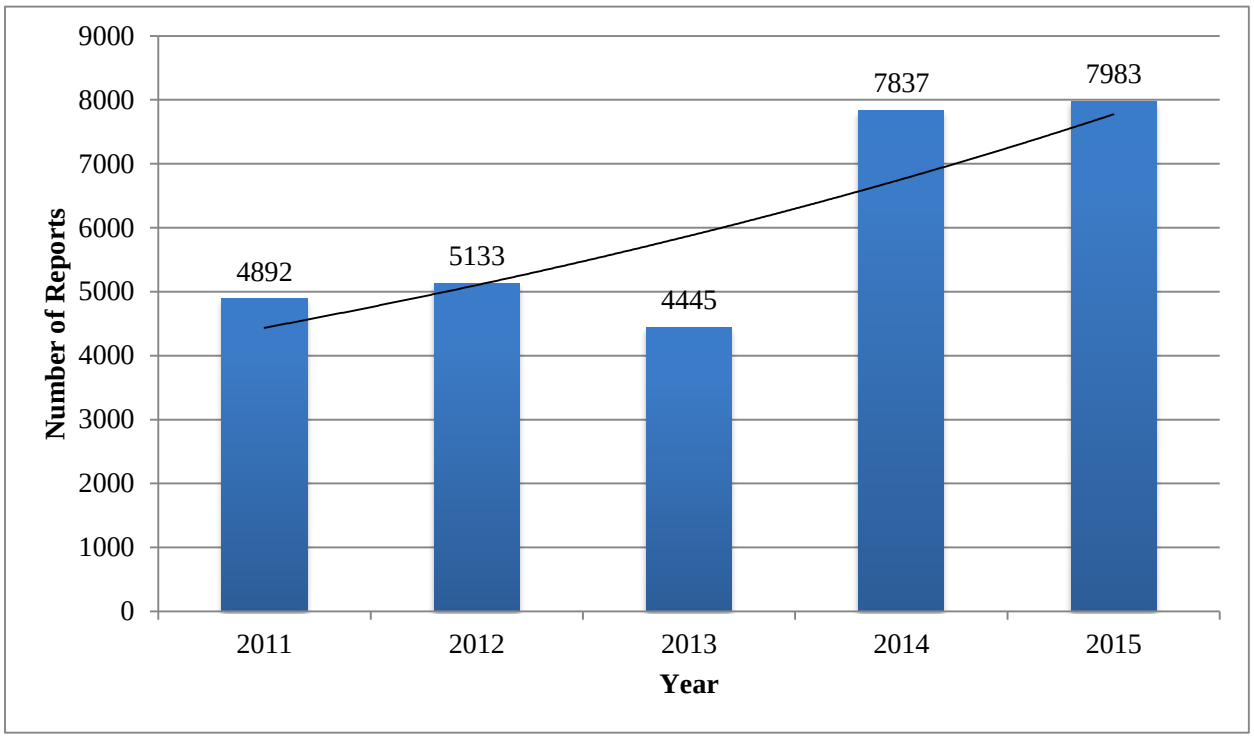
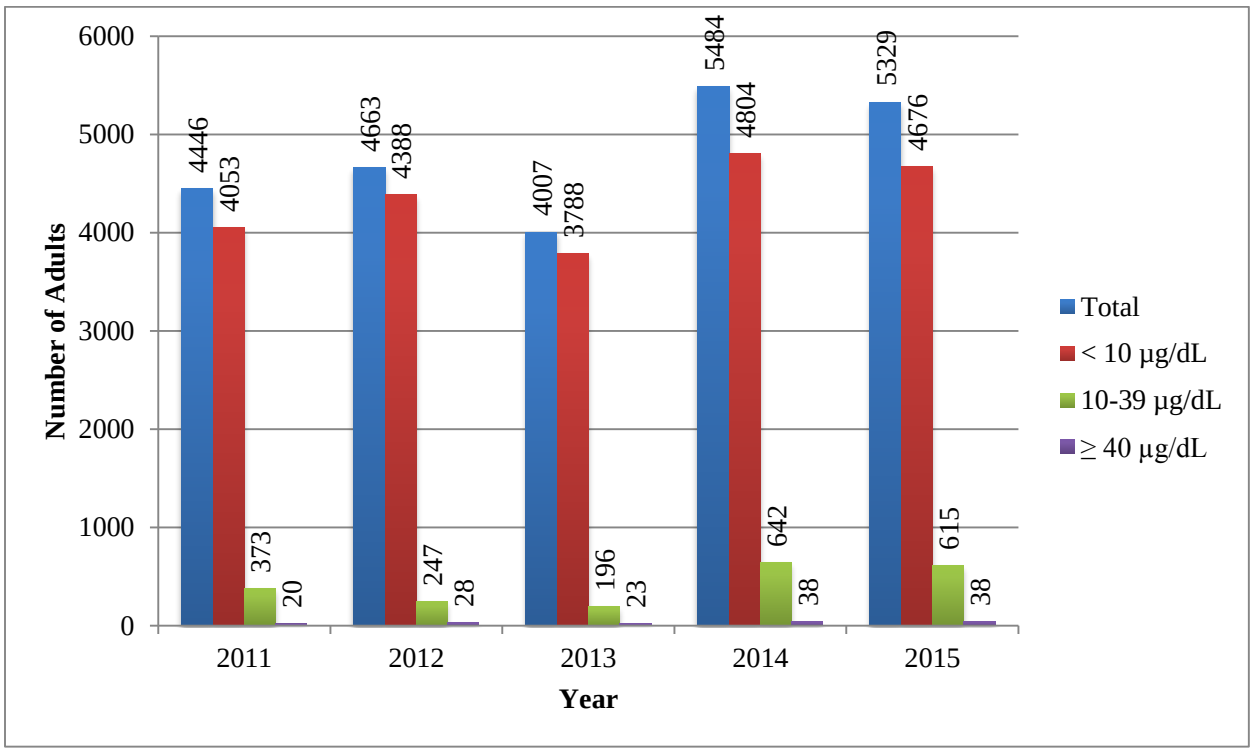
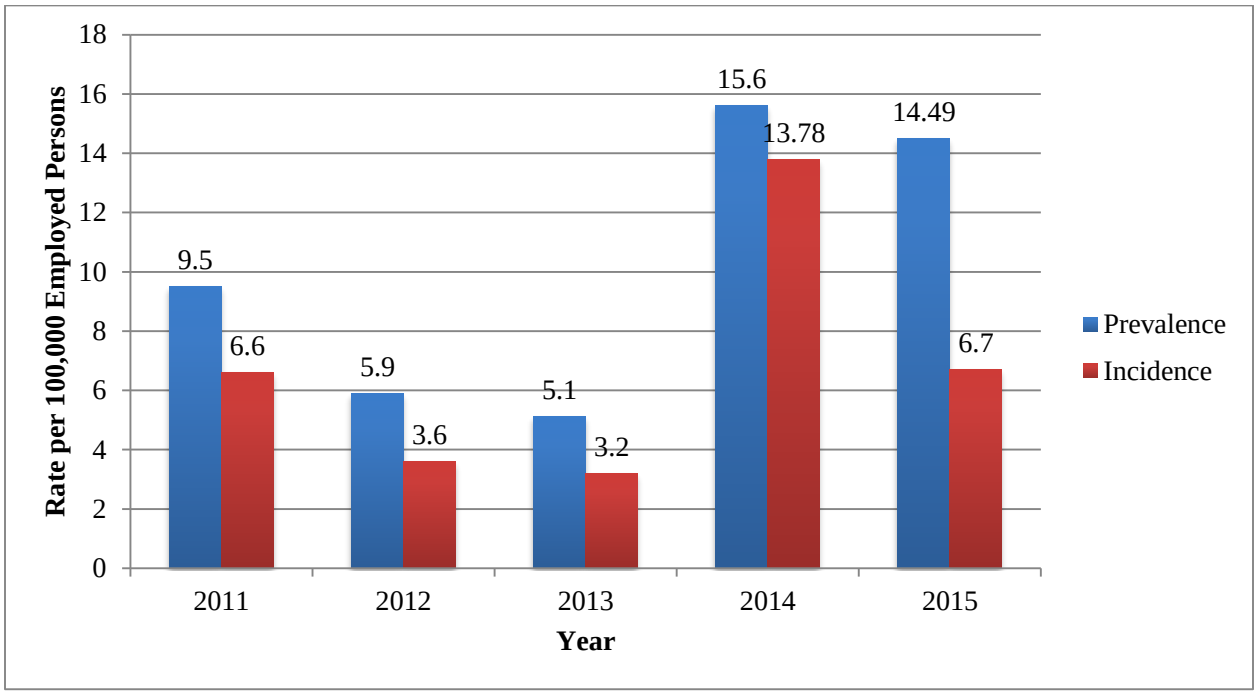


Figure 2. Number of Adults Tested by Blood Lead Level* in NC: 2011 – 2015



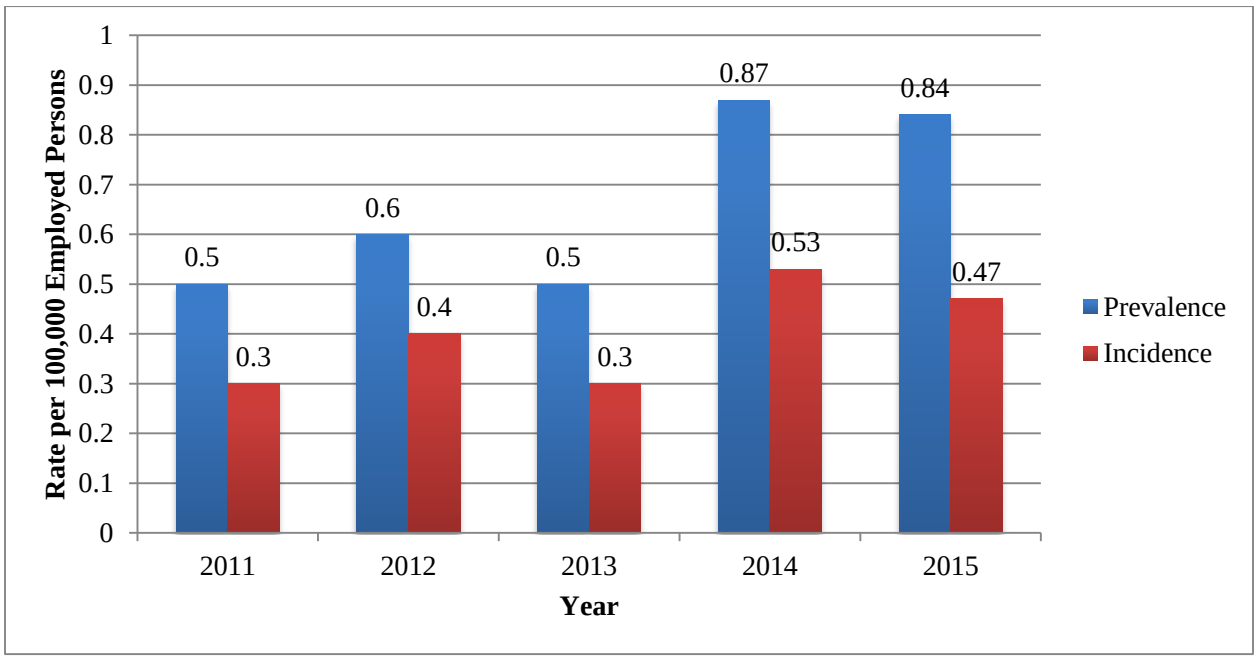
*Calculated using highest BLL per individual

Figure 3. Prevalence and Incidence* of Blood Lead Levels ≥ 10 µg/dL per 100,000 Employed Persons in NC: 2011 – 2015



*Employment data provided by the US Bureau of Labor Statistics[8]

Figure 4. Prevalence and Incidence* of Blood Lead Levels ≥ 40 µg/dL per 100,000 Employed Persons in NC: 2011 – 2015



*Employment data provided by the US Bureau of Labor Statistics[8]

Definitions and Technical Notes

ABLES: Adult Blood Lead Epidemiology and Surveillance.

Adult: Individuals age 16 years or older.

BLL: Blood lead level.

EBLL: Elevated blood lead level (BLL ≥10 µg/dL).

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Incidence: Measures the frequency of new cases of a disease or condition.

> Formula[3]: [(Case with a BLL of ≥ 10 µg/dL reported in the calendar year, but was not reported in the immediately preceding year with a BLL ≥10 µg/dL) / (Annual number of employed persons aged 16 and older)] x 100,000.

Employment Data: Annual employment data were collected from the Geographic Profile of Employment and Unemployment for the years 2011-2015. The numbers originated from the Current Population Survey (CPS), a nationwide survey of 60,000 households conducted by the United States Bureau of Labor Statistics (BLS).

Prevalence: Measures the frequency of an existing disease or condition.

> Formula[3]: [(Annual number of adult residents with a BLL ≥ 10 µg/dL) / (Annual number of employed persons aged 16 and older)] x 100,000.

Rates: All rates are per 100,000 employed persons in North Carolina. Rates are not adjusted for age.

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