



Blood Lead Concentrations of Children in the United States: A Comparison of States Using Two Very Large Databases

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Objectives To determine whether there are substantial differences by state between 2 large datasets in the proportion of children with elevated blood lead levels (BLLs); to identify states in which the percentage of elevated BLLs is high in either or both datasets; and to compare the percentage of elevated BLLs in individual states with those of children living in Flint, Michigan, during the months when these children were exposed to lead-contaminated drinking water.

Study design Tables of BLLs for individual states from the Quest Diagnostics and the Centers for Disease Control and Prevention datasets for 2014-2015, containing more than 3 million BLLs of young children < 6 years old, were constructed to compare the Quest Diagnostics and Centers for Disease Control and Prevention data with one another and with BLLs available for Flint children for 2014-2015.

Results For some states, the percentages of BLLs ≥ 5.0 $\mu\text{g}/\text{dL}$ are similar in the 2 datasets, whereas for other states, the datasets differ substantially in the percentage of BLLs ≥ 5.0 $\mu\text{g}/\text{dL}$. The percentage of BLLs ≥ 5.0 $\mu\text{g}/\text{dL}$ is greater in some states in both datasets than observed in Flint when children were exposed to contaminated water.

Conclusion The data presented in this study can be a resource for pediatricians and public health professionals involved in the design of state programs to reduce lead exposure (primary prevention) and identify children with elevated BLLs (secondary prevention). (*J Pediatr* 2017;185:218-23).

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Reducing lead exposure has been a major public health initiative in the US for more than a half century. Despite the substantial success of these efforts in reducing the mean blood lead levels (BLLs) of children aged 6 months to 5 years from 16 $\mu\text{g}/\text{dL}$ in 1976-1980 to less than 5.0 $\mu\text{g}/\text{dL}$ in 2016, many children still have BLLs above the current Centers for Disease Control and Prevention (CDC) “reference value” of 5.0 $\mu\text{g}/\text{dL}$ and continue to be exposed to lead from a variety of sources.¹⁻⁴ The percentage of children with BLLs ≥ 5.0 $\mu\text{g}/\text{dL}$, however, varies substantially from city to city and state by state.^{5,6} In 2014, the percentage of children in Flint, Michigan, who had BLLs greater than the reference value of 5.0 $\mu\text{g}/\text{dL}$ was reported to double after a switch in their drinking water supply to a different source that was not treated adequately to prevent the leaching of lead from lead plumbing in their drinking water service lines.^{7,8} This event attracted the attention of the national and international media and resulted in a substantial resurgence of concern about lead exposure and elevated blood lead concentrations in young children.⁹

A study published in June 2016 summarized the results of more than 5 million BLLs for children (<6 years of age) from all 50 states that were determined in the laboratories of Quest Diagnostics during the 6-year period 2009-2015.⁶ A separate large database of national BLLs is available on the CDC website and includes data on BLLs in most states since 1997.⁵ Both the Quest Diagnostics publication and the CDC state and national surveillance data include the percentages of children with BLLs ≥ 5.0 $\mu\text{g}/\text{dL}$. The CDC surveillance data further provide the percentages of children with BLLs ≥ 10.0 $\mu\text{g}/\text{dL}$. The current study was initiated to take advantage of the existence of these 2 large, separate datasets containing >55 million blood lead concentrations for young children.

Although BLLs for some individual children may be present in both databases, the use of both datasets should provide a better estimate of the national and state-by-state percentages of BLLs ≥ 5.0 $\mu\text{g}/\text{dL}$, as opposed to estimates based on only one of the datasets. The objectives of the study were (1) to determine whether there are substantial differences by state between the 2 datasets in the proportion of children with elevated BLLs; (2) to identify states in which the percentage of elevated

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BLL Blood lead level
CDC Centers for Disease Control and Prevention

BLLs is high in either or both datasets; and (3) to compare the percentage of elevated BLLs in individual states with those of children living in Flint during the months when these children were exposed to lead-contaminated drinking water.

Methods

This report compares and analyzes BLLs data in both the Quest Diagnostics and the CDC surveillance datasets. We evaluated only the most recent data from each dataset: BLLs in the Quest dataset for the period May 2014 through April 2015 (n = 507 750 BLLs) and BLLs in the CDC dataset for calendar year 2014 (n = 2 496 140 BLLs). Data for Flint were for the period when the drinking water concentration of lead was greatest, April 2014 to January 2015. The latter time period coincides with the months of blood sampling during 2014-2015 for the CDC and Quest data.

For 2014, the CDC received lead surveillance data from 29 states and the District of Columbia and reported the number of total confirmed cases for various BLL ranges, including 5-9 $\mu\text{g}/\text{dL}$, 10-14 $\mu\text{g}/\text{dL}$, 15-19 $\mu\text{g}/\text{dL}$, 20-24 $\mu\text{g}/\text{dL}$, 25-44 $\mu\text{g}/\text{dL}$, 45-69 $\mu\text{g}/\text{dL}$, and ≥ 70 $\mu\text{g}/\text{dL}$. The CDC conducted “de-duplication” to ensure that there was only one BLL per child. We reorganized the CDC data to show the proportion of children with

BLLs ≥ 5.0 $\mu\text{g}/\text{dL}$ and ≥ 10.0 $\mu\text{g}/\text{dL}$ to identify those with “high” and “very high” BLLs, respectively.

The Quest Diagnostics study contains BLL data from 36 states and the District of Columbia that include the total population tested as well as the proportion of children with BLLs ≥ 5.0 $\mu\text{g}/\text{dL}$. To avoid duplication, the Quest data include only the first BLL on a child when more than one BLL was available for the child. Data for some states were only available in 1 of the 2 datasets. Data for 26 states and the District of Columbia were available in both datasets, and a Spearman correlation coefficient was calculated to determine the extent of correlation between the Quest Diagnostics and CDC data. The χ^2 and Wilcoxon signed rank tests were also used to compare CDC and Quest state data.

Results

Table I contains the CDC data for calendar year 2014 for the US, 28 states, the state of New York excluding New York City, New York City, and the District of Columbia. Data for Flint from a separate source are also included in **Table I**.⁸ The range of values for the percentage of children with BLLs ≥ 5.0 $\mu\text{g}/\text{dL}$ during 2014 was 1.07% for Arizona to a surprisingly high 44.15% for the neighboring state of New Mexico. The

Table I. Blood lead levels in children <6 years of age, as reported by CDC for 2014

Numbers	State	Population < 6 y of age	Number of children tested	% BLL ≥ 5.0 $\mu\text{g}/\text{dL}$	% BLL ≥ 10.0 $\mu\text{g}/\text{dL}$
1	New Mexico	173 918	11 129	44.15	0.17
2	Pennsylvania	877 769	139 774	8.53	1.28
3	Mississippi	252 345	46 279	6.88	0.23
4	New York (excluding New York City)	1 386 618	37 432	6.67	1.46
5	Vermont	38 743	5097	6.55	0.57
6	New Hampshire	84 767	13 701	6.24	0.67
7	Ohio	866 996	149 538	5.99	0.96
8	Illinois	1 005 860	138 537	5.98	1.15
9	Wisconsin	431 404	88 006	5.57	0.77
10	West Virginia	125 045	1154	5.29	0.69
11	Rhode Island	69 386	26 824	5.12	0.81
12	Connecticut	245 428	75 229	5.00	0.69
13	Flint, Michigan	9622	1694	5.00	0.80
14	Louisiana	375 722	19 007	4.95	0.67
15	Indiana	522 074	38 140	4.61	0.54
16	US totals	24 258 220	2 496 140	4.25	0.53
17	Texas	2 315 928	184	3.80	1.09
18	Michigan	720 314	138 798	3.60	0.46
19	Massachusetts	442 592	212 013	3.40	0.37
20	Kentucky	338 977	13 631	3.34	0.37
21	New Jersey	652 622	172 846	3.22	0.46
22	Alabama	365 443	24 137	3.18	0.51
23	Oklahoma	316 500	42 086	2.83	0.50
24	Oregon	284 723	12 041	2.60	0.12
25	Georgia	825 000	104 985	2.46	0.15
26	California	3 036 510	146 192	2.43	0.25
27	Maryland	437 188	109 031	2.38	0.30
28	Colorado	413 949	16 555	2.25	0.17
29	New York City	639 380	315 767	2.21	0.29
30	Minnesota	427 426	88 833	1.95	0.25
31	Tennessee	489 413	84 223	1.86	0.14
32	District of Columbia	38 156	16 300	1.74	0.31
33	Arizona	546 609	49 732	1.07	0.14

States, District of Columbia, Flint, Michigan, and US totals are listed in decreasing order of percentage of BLLs ≥ 5.0 $\mu\text{g}/\text{dL}$. Data are for calendar year 2014 except for Flint, Michigan, data, which are for April 2014 to January 2015, the period when the drinking water concentration of lead was greatest. The CDC conducted “de-duplication” to ensure only 1 BLL per child. One objective of this study is to compare BLLs of Flint, Michigan, children with statewide BLLs of children living in other states. Flint BLLs are provided in bold to facilitate these comparisons. The US totals are also in bold so that values for Flint or any state can be more easily compared to the US data.

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