

CDC uses a [blood lead reference value](#) (BLRV) of 3.5 micrograms per deciliter ($\mu\text{g}/\text{dL}$) to identify children with higher levels of lead in their blood compared to most children. This level is based on the 97.5th percentile of the blood lead values among U.S. children ages 1-5 years from the 2015-2016 and 2017-2018 National Health and Nutrition Examination Survey (NHANES) cycles. Children with blood lead levels at or above the BLRV represent those at the top 2.5% with the highest blood lead levels.

Conducting blood lead prevalence studies

Training module provided by the U.S. Centers for Disease Control and Prevention.

Outline

- Why conduct lead prevalence studies?
- Examples of data that lead prevalence studies can provide
- How to do lead prevalence studies
- NB description of environmental component of an investigation is in Module C.iv (Environmental Sampling).

Many sources of lead can contribute to blood lead levels

- Gasoline (no longer a major source in most countries)
- Battery recycling
- Consumer products
- Some traditional medicines
- Unregulated or cottage industries
- Electronic waste, child labor
- Localized sources such as mines/smelters
- Lead paint

Reference C.iii.1

What can environmental lead sampling tell you?

- Location of areas of lead contamination, enabling mapping of areas of high and low lead concentrations
 - Helps identify source(s) of exposure in population known to have high blood lead levels (BLLs).
 - Identifies at-risk populations who should have BLLs checked.
 - Provides populations with measures to reduce or stop exposure.
- Data can be used to direct and evaluate remediation efforts.

Instructor Note: For detailed description of how to collect environmental lead samples, please refer to Module c.iv (Conducting Environmental Sampling).



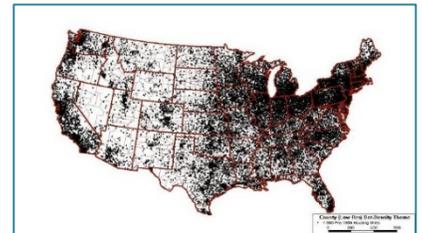
Blood lead prevalence studies can link environmental sources to lead exposure

Examples

- Lead from paint (USA)
- Lead from gasoline (USA)
- Tracking national prevalence of blood lead from all sources (USA)
- Lead from mining (Nigeria)
- Negative studies (Puerto Rico)

Lead-based paint in housing (USA)

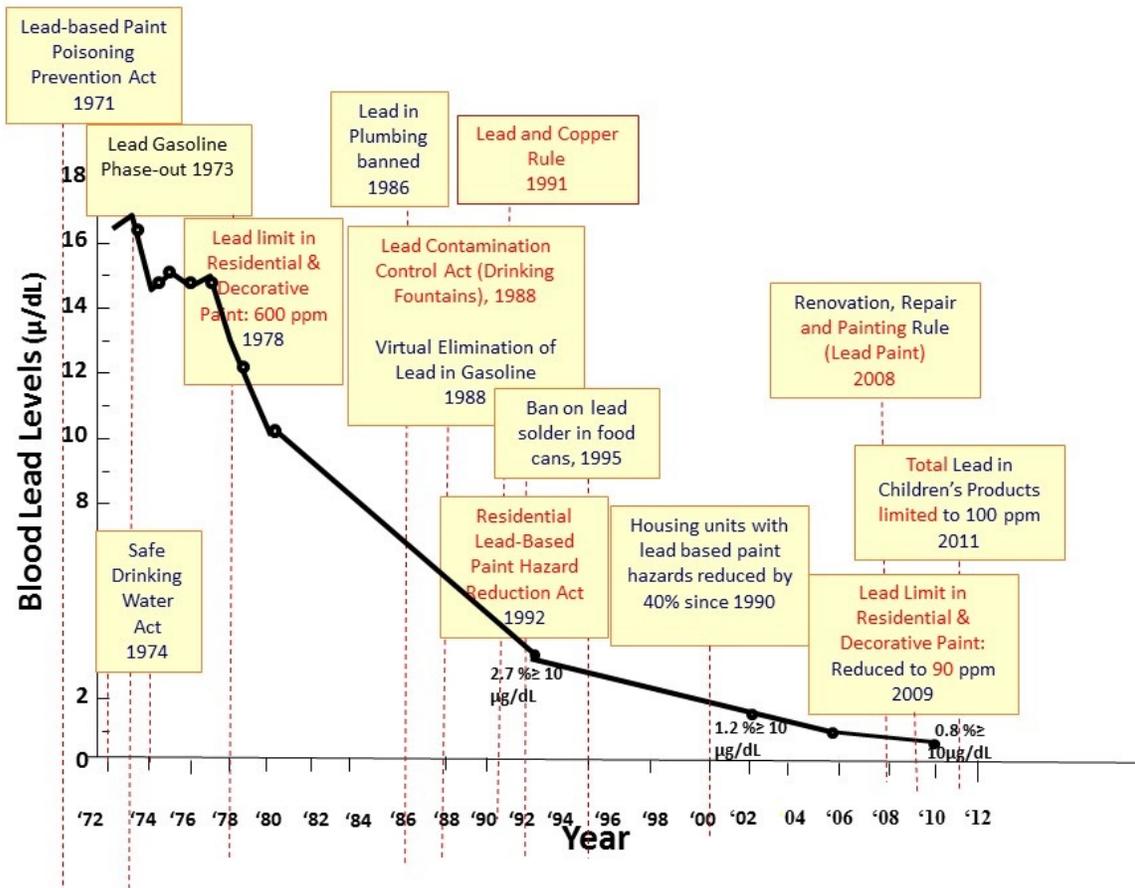
- Nearly 38 million housing units contain lead-based paint
- 23.2 million housing units (25% of the nation's housing) have significant lead-based paint hazards
- 1.1 million homes with significant lead-based paint hazards housed low income families with children under the age of 6



Reference C.iii.2

Instructor Note: Because lead-based paint is the most important source of lead exposure for young children, the first essential element of primary prevention is implementation of strategies to control lead paint-contaminated house dust and soil and poorly maintained lead paint in housing.

Impact of lead poisoning prevention policy on reducing children's blood lead levels



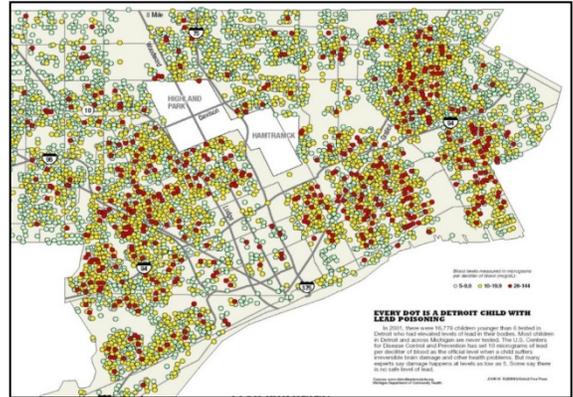
Some prevalence studies in USA

Detroit, Michigan

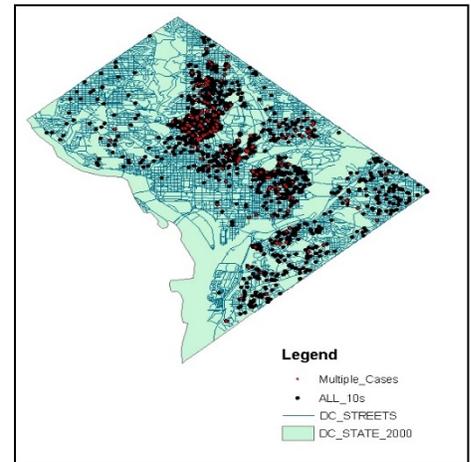
Every dot is a lead-poisoned child.

- Green = 5–9 micrograms per deciliter ($\mu\text{g}/\text{dL}$)
- Yellow = 10–20 $\mu\text{g}/\text{dL}$
- Red = 22–140 $\mu\text{g}/\text{dL}$

Reference C.iii.3.



Washington, DC



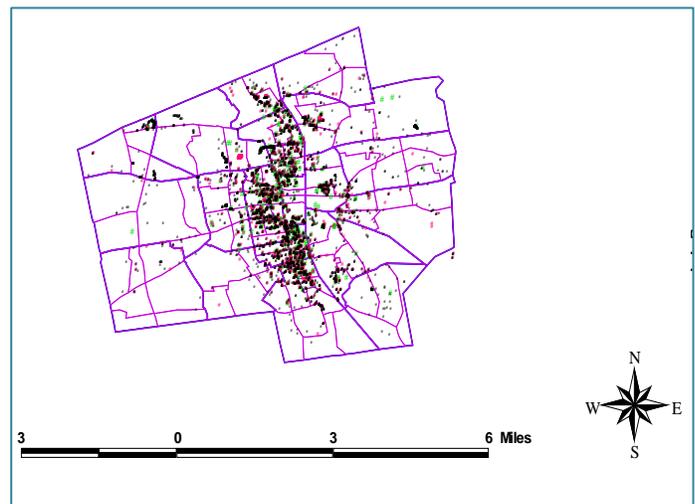
Brockton, Massachusetts

Every dot is the address of a lead-poisoned child in the last 10 years.

Green = 1 child.

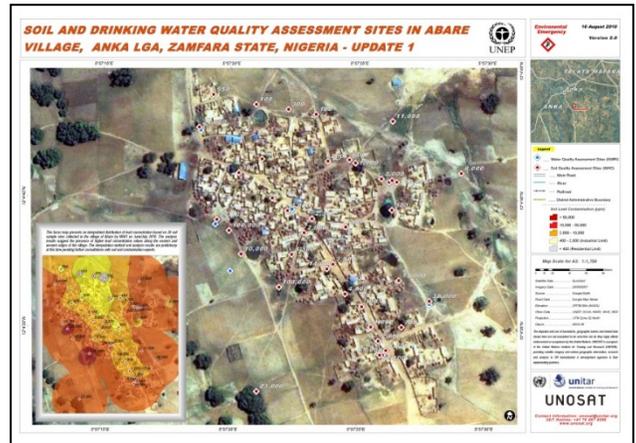
Red = 2 children.

Black dot = more than 2 children.



Nigeria lead poisoning epidemic—lead released from gold ore processing

- In 2010, 119 family compounds in Zamfara, Nigeria, were surveyed
 - 26% of children aged <5 years had died in the previous 12 months.
 - 82% of deaths involved convulsions.
 - 71% of households processed gold ore inside compounds.
 - 97% of living children <5 yr had BLLs >45 µg/dL (range: 36.5 to 445 µg/dL)
- Response involved defining scope of problem, cleaning up sites, conducting blood lead surveillance and medical management, and promoting safe mining practices



Reference C.iii.9

Negative studies

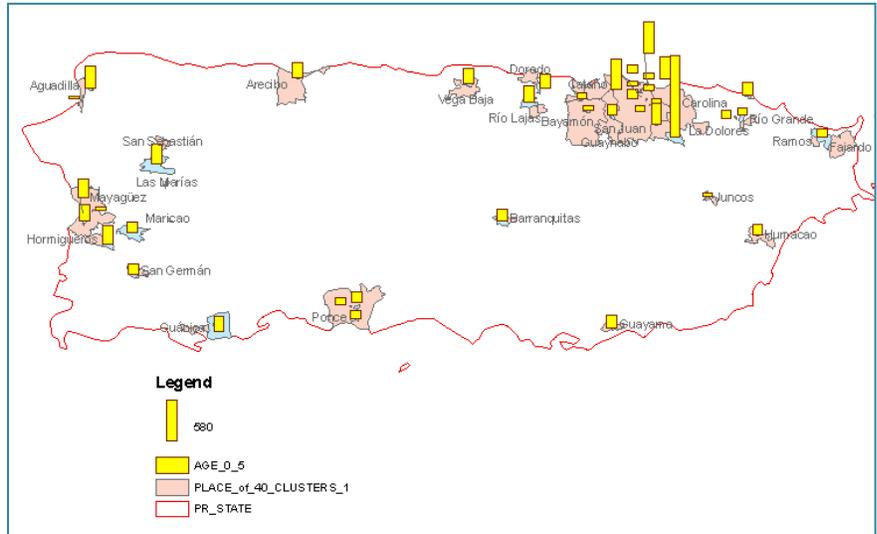
- Must have strong data to demonstrate the absence of a problem.
- Need to consider all possible sources of lead when planning the study.
- Study design should be powerful enough to have identified a problem if it existed.
- Puerto Rico example shown below.

Prevalence study sampling areas in Puerto Rico

Island divided into clusters based on U.S. census block groups (pink and blue)

Clusters selected with a stratum with probability proportional to estimated population size. (Yellow block height indicates number of children 0–5 years old.)

Sample of households randomly selected within each cluster so that each household had equal probability of being selected.



All eligible children in each selected household were enrolled in the study.

Instructor Note: The sampling frame for this survey divided the island into clusters based on U.S. census block groups (pink and blue).

Clusters were selected with a stratum with probability proportional to estimated population size. (Yellow block height indicates the number of children 0–5 years of age.)

A sample of households was selected within each cluster using systematic random sampling with each household having equal probability of being selected.

All eligible children in each selected household were enrolled in the study.

Blood lead level results in Puerto Rico

Blood Lead Level (µg/dL)	Number of Children Sampled (N=440)	Percent
<5	425	96.6%
5–9	12	2.7%
10–14	2	0.5%
>14	1	0.2%

Puerto Rico’s weighted prevalence of BLLs ≥ 10 µg/dL is 1%; BLLs ≥ 5 is 3.4%.

Instructor Note: Out of 440 children sampled, 425 or 96.6% of samples had BLL less than 5 micrograms per deciliter.

12 children had BLLs between 5–9 micrograms per deciliter. Two children had BLLs between 10–14 micrograms per deciliter, and only one child had BLL greater than 14 micrograms per deciliter.

Overall, Puerto Rico’s weighted prevalence of BLLs ≥ 10 is 1%; ≥ 5 is 3.4%.

NB below is the Dignam 2015 paper – the results are different from those in the slide

Context: Limited data exist about blood lead levels (BLLs) and potential exposures among children living in Puerto Rico. The Puerto Rico Department of Health has no formal blood lead surveillance program.

Objectives: We assessed the prevalence of elevated BLLs (≥ 5 micrograms of lead per deciliter of blood), evaluated household environmental lead levels, and risk factors for BLL among children younger than 6 years of age living in Puerto Rico in 2010.

Methods: We used a population-based, cross-sectional sampling strategy to enroll an island-representative sample of Puerto Rican children younger than 6 years. We estimated the island-wide weighted prevalence of elevated BLLs and conducted bivariable and multivariable linear regression analyses to ascertain risk factors for elevated BLLs.

Results: The analytic data set included 355 households and **439** children younger than 6 years throughout Puerto Rico. The weighted geometric mean BLL of children younger than 6 years was 1.57 µg/dL (95% confidence interval [CI], 1.27-1.88). The weighted prevalence of children younger than 6 years with BLLs of 5 µg/dL or more was **3.18% (95% CI, 0.93-5.43)** and for BLLs of 10 µg/dL or more was **0.50% (95% CI, 0-1.31)**. Higher mean BLLs were significantly associated with data collection during the summer months, a lead-related activity or hobby of anyone in the residence, and maternal education of less than 12 years. Few environmental lead hazards were identified.

Conclusions: The prevalence of elevated BLLs among Puerto Rican children younger than 6 years is comparable with the most recent (2007-2010) US national estimate (BLLs ≥ 5 µg/dL = 2.6% [95% CI = 1.6-4.0]). Our findings suggest that targeted screening of specific higher-risk groups of children younger than 6 years can replace island-wide or insurance-specific policies of mandatory blood lead testing in Puerto Rico.

Environmental results in Puerto Rico

Sample Type	No. of Households Sampled (N=259)	Range of Results	No. of Households Exceeding Environmental Protection Agency (EPA) Action Level (%)	EPA Action Level
Soil	178	2.2–240 ppm	0	400 ppm
Water	257	<3–22 µg/L	3 (1.2)	15 µg/L
Dust Floor Composite	235	<0.5–180 µg/ft ²	1 (0.4)	40 µg/ft ²
Dust Window Composite	230	<0.5–115.2 µg/ft ²	0	250 µg/ft ²

Instructor Note: Environmental analyses were collected from 259 households.

Only 3 households exceeded the U.S. Environmental Protection Agency’s (EPA) action level of 15 micrograms per liter of lead in water.

And only one household exceeded the EPA action level of 40 micrograms per square feet of dust floor composite.

Conclusions—Puerto Rico

- The prevalence of BLLs (≥ 10 µg/dL) among Puerto Rican children aged <6 years was low (1%) and comparable to the 2007–2010 U.S. national estimate.
- Few environmental lead hazards were identified in the households surveyed.
- Carefully designed studies including blood and environmental samples can reliably identify communities with low risk for elevated BLLs.

Conducting blood lead prevalence studies related to lead paint

- Having reviewed the utility of blood lead studies, we will now consider the actual conduct of such studies.
- Blood lead studies must be conducted in a scientifically rigorous manner to be reliable and of value, both for public health and regulatory actions.
- These studies can be complemented by an environmental investigation – see Module C.iv (Environmental Sampling).

Why conduct blood lead prevalence studies to evaluate the role of lead paint?

- Determine if lead paint is contributing to BLLs in the population.
- Determine the degree and extent to which lead paint is contributing to BLLs in the population.
- Establish a baseline before preventive action so that impact can be monitored.
- Demonstrate efficacy of preventive or regulatory action.

Possible outcomes of blood lead prevalence studies

- Early identification and intervention for children with elevated BLLs.
- Surveillance to monitor progress toward reduction of BLLs and elimination of exposure.
- Development and strengthening of partnerships among the agencies responsible for eliminating childhood lead poisoning lead paint exposures.
- Research to further improve prevention methods.

Value of local/regional blood lead studies to identify high-risk groups

- Inequitable lead exposures exist in many communities.
- Developing capacity to respond to cases with elevated BLLs, targeting screening to at-risk subpopulations, and identifying lead “inequitable hotspots” are crucial to primary and secondary prevention efforts.
- In the absence of national surveillance data, blood lead prevalence studies are advantageous.

Local/regional blood lead investigations

- Small area prevalence studies to assess BLLs are population-based and cross-sectional.
 - Provide an unbiased estimate of BLLs in a given geographic location.
 - Serve as a tool to understand risk factors for elevated BLL.
 - Can supplement or complement local blood lead surveillance data and national surveys such as the U.S. National Health and Nutrition Examination Survey (NHANES).

Prevalence study design considerations

- Involve a statistician.
- Identify a specific target population/study area.
- Review available demographic, census, and geographic data.
- Determine the necessary sample size.

Prevalence study design considerations

- Adequate response rate
 - Ensure sufficient numbers of participants for stable estimates of lead levels.
 - Consider need for appropriate (modest) incentives to participate.
- Information about nonresponders
 - Determine if the results are generalizable to the population of interest.
- Field work
 - Determine best way to approach the people you want to reach.
 - Seek help of community leaders in planning and implementing study.
 - Consider ethnicity and gender of field workers and language and literacy level of study materials).

Instructor Note:

Adequate response rate: Consider whether you should offer incentives to participants. Are the incentives sufficient to show respect and thank people for participation while not so valuable that they might seem coercive?

Information about nonresponders: Answer the question “Are those people who enrolled in my study different from those who refused or could not be contacted?” in terms of characteristics known to be associated with lead exposure. This might be people from a particular ethnic group or occupation who either were over- or under-represented or enrolling older children who are easier to test but may have ‘aged out’ of being at high risk for lead exposure.

Field work: Who are the trusted leaders in the community (political, religious, cultural) and have you sought their help in preparing the for the study? Are the field workers from the same ethnic background as the population? Are study materials in the right language and the right literacy level?

Prevalence study design considerations

- Blood collection—venous or capillary samples
 - Venous samples need trained phlebotomist but less likely to be contaminated.
 - Capillary samples perceived as less painful, do not require same level of training, but more prone to contamination.
- Partnerships
 - Local public health unit, university, nongovernmental organizations
- Resources for children with high BLLs
 - Information/training to local clinical and public health care providers on management of lead poisoning.
 - Availability of chelation therapy—facilitate provision.

Instructor Note:

Blood collection: Venous blood samples require trained phlebotomy staff but are easier to collect and less likely to be contaminated by ambient lead, whereas capillary samples are often perceived to be less painful and do not require the level of training required to do venous samples.

Partnerships: Local medical, nursing or schools of public health may be quite interested in participating in the field study to give their students the practical experience. The joint CDC country office/Ministry of Health Field Epidemiology Training Program may also be interested.

Resources for children: Before conducting the study, meet with local clinical and public health care providers and groups (pediatric society/pediatric clinic) and conduct a grand rounds or other information session on the identification and treatment of children with lead poisoning. Include the resources the medical providers can expect from public health, the availability of chelating agents, and the protocol for follow up. This information is provided in this toolkit.

Examples of study objectives

- Obtain an unbiased prevalence estimate of BLLs among children aged 1–5 years (12–72 months) living in a specific geographic area.
- Obtain a weighted geometric mean BLL, a measure of the BLL distribution (confidence interval or standard deviation) and a weighted prevalence of elevated BLLs (e.g., ≥ 5 $\mu\text{g}/\text{dL}$ and ≥ 10 $\mu\text{g}/\text{dL}$).
- Obtain an unbiased estimate to identify low prevalence areas: use the actual result provide by the instrument, not an imputation of values below the level of detection.
- Identify risk/protective factors and sources of exposure for lead.

Selection of the study area

- Study area is the geographic area where the study population is recruited and sampled.

- A study area proximal to a point source is generally considered to be within 2.7 km of the point source.
- If the study area is quite large (such as a neighborhood, city, county, community, territory, or state), a simple random sample is not logistically feasible.
- Household is the primary sampling unit.
- The study area must be divided into manageable portions, called clusters. A cluster is a group of households within a geographic area (e.g., census tract or block group).

Instructor Note: The 2.7-km radius definition is the average radius that elevated blood lead measures have been reported based on a review of 11 studies measuring blood lead levels and point source exposures (Benin 1999; Garcia-Vargas 2014; Baker 1977; Stafilov 2010; Pilgrim 1994; Hegde 2010; Albalak 2003; Fritsch 2010; Paoliello 2002; Willmore 2006; Meyer 1999).

A representative, simple random sample child blood lead survey could be done immediately nearby a point source but for a larger area a representative, population-based, cross-sectional child blood lead survey using household as the primary sampling unit randomly selected from a cluster of households is more realistic.

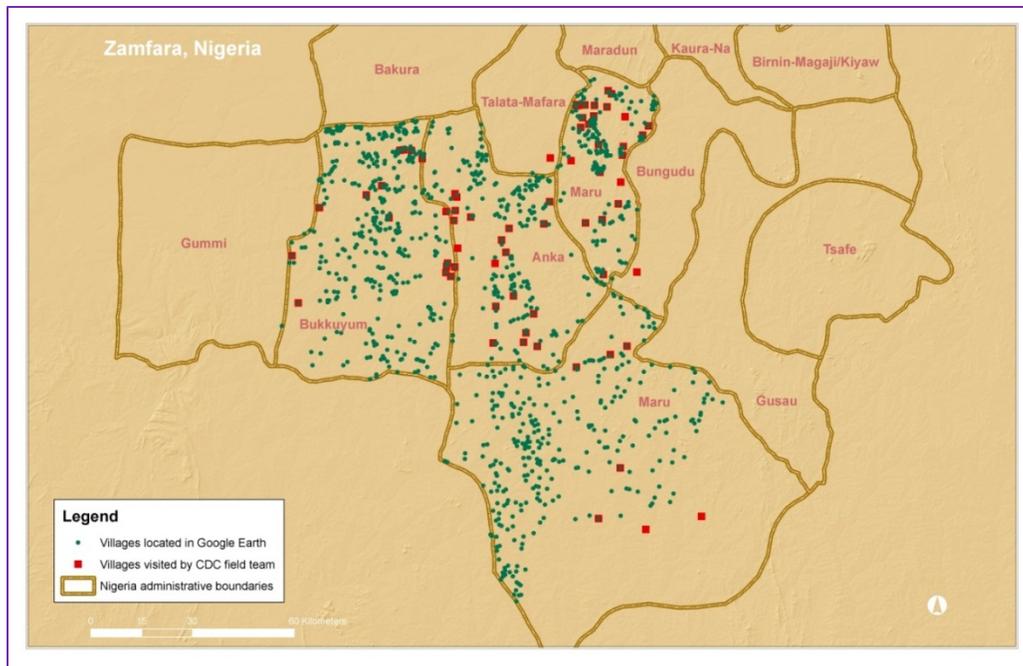
Selection of the study population

- Defined by, for example,
 - Age,
 - length of time at residence,
 - length of time in an area close to a point source,
 - parental participation in hobby/occupation,
 - member of a particular ethnicity known to frequently use lead-containing products (eyeliner, traditional medicines etc.).

Instructor Note: Review any previous studies done in the general area of interest (city, state or country) or close to similar presumed point source (informal metal recycling, large scale mining, high-risk housing, etc.) to identify factors that best predict high blood lead levels in the population of interest (occupation, ethnicity, age).

Additional data that can be used

- Census data available
 - Can calculate estimates of the underlying population and create shape files using GIS to map the area at desired level of resolution.
- Census data unavailable
 - Political boundaries.
 - Geographic boundaries.
 - LandScan mapping of population distribution.



Instructor Note: If census data are available, estimates of the underlying population can be calculated and shape files created using geographic information system (GIS) to map the area at desired level of resolution. If census data are not available, Internet Landscan (such as Google Earth) can provide a fairly good representation of population density. The map shows three local government areas in a remote area of Nigeria. The green dots are the villages according to Landscan. Field teams visited the villages in red and you can see that the overlap is quite good, with more than 87% of villages visited in the exact location identified by Landscan or reasonably close.

Reference C.iii.11

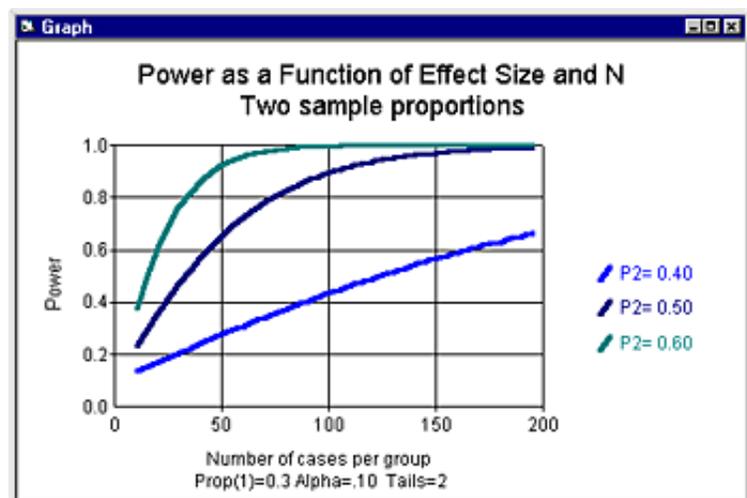
Study design considerations - outline

The next few sections discuss the following design considerations:

- Sample size
- Sampling methodology
- Response rate
- Data collection and entry

Sample size and sampling methodology

- Statistical methods for determining number of participants
 - Power calculation
- Eligibility criteria
 - Factors of interest in study; e.g., age, occupation
- Number of eligible participants in study area
 - Baseline population estimate
- Response rate
 - How many eligible participants will enroll and complete study?
 - Acceptance by population of interest



Instructor Note:

Statistical methods: It is important to consult with a biostatistician when developing the study protocol to obtain a realistic estimate of the number of participants needed to generate stable estimates. Underpowered studies are likely to result in false negative results and this may allow dangerous conditions to persist since they were missed because of the small sample.

Eligibility criteria: Define the criteria you will use to select participants (age, occupation, location, etc.).

Number of eligible participants: Using your best estimate, how many participants are in the geographic area you will be studying?

Enrollment: Given the community preparation, partnerships and incentives, and any information on previous studies, calculate the percent of eligible participants who will enroll in and complete the study.

Response rate

- Minimize the questionnaire burden in field to maximize the response rate (e.g., assess need to ask personal questions).
- Use a tracking form to account for all attempted and completed interview outcomes.
- Collect information about nonresponders to determine their similarity to responders.
- Take into account differences between nonresponders and responders in the analysis.

Instructor Note: In lead prevalence field studies, the length of time for a participant is very short, usually 1–2 hours. However, if you intend to follow the participants over time, you will also have to account for dropouts and how those who do not complete the study may differ in important ways compared to those who do finish the study.

Data collection and entry

- Paper forms vs. laptop/mobile device—depends on resources available at study area.
- Visitation protocol—describes roles and activities of study team.
- Maps—ideally should be generated at level of households/addresses, used for simple or cluster randomization.

Instructor Note:

Paper vs. device: Investigate the availability of IT support, photocopying equipment, etc., and select the most appropriate methods to collect demographic and questionnaire data.

Visitation protocol: The study team is the main link between the study investigators and the study population and usually includes

- **A spokesperson**—to introduce the team and study to community members, consent form administration, questionnaire administration, and incentive dispenser;
- **A logistics manager**—to fill in visitation tracking and manage navigation, blood storage, and chain-of-custody issues;
- **An environmental sampler**—responsible for conducting the water, soil and indoor dust sampling;
- **A pediatric phlebotomist**—responsible for obtaining the blood sample from the child.

Use of maps: If possible, maps should be generated at the level of households or addresses. These can be used for either a simple or cluster randomization.

Labels are essential

- Each data source has a corresponding label. It is very important to attach the appropriate label to the correct data source.
- A typical set of labels is as follows:
 - Consent-C
 - Child Questionnaire—CQ
 - Household Questionnaire—HQ
 - Dust Floor—DF-1 (Front Entrance)
 - Dust Floor—DF-1 (Child's Sleeping Area)
 - Dust Window—DW (Child's Sleeping Area)
 - Blood Sample—B
 - Soil—SO
 - Water—W
 - Environmental Sampling Form—ES
 - Extra 1—X1
 - Extra 2—X2

Instructor Note: A sample without a label is a wasted sample.

Labels are computer generated, bar-coded sticky labels.

Labels connect environmental samples to the child who had the blood lead test.

Data collection and entry

- Can use readily available software to construct data template (e.g., Excel, Access, FAST software, GIS software).
 - Analyze using free/low-cost data analysis software (e.g., EpiData or EpiInfo).
 - Download EpiInfo for free at <http://wwwn.cdc.gov/epiinfo/7/>.
- Maintain a data dictionary to record the definitions of the variable labels as the data template is constructed. **[Important!]**

Instructor Note: **Software:** Readily available software such as Excel and Access can be used to construct a data template. It is very important to develop a data dictionary that keeps a record of the definitions of the variable labels as the data template is constructed. No-cost and low-cost data analysis software such as EpiInfo and EpiData can analyze data entered into Excel or Access databases.

Field work considerations - outline

The next few sections discuss the following field-work considerations:

- Study timeframe
- Field team composition, hours of work
- Safety and comfort
- Results letters, referral to other health agencies

Study timeframe

- Weather
 - Soil samples can be difficult to collect during rainy seasons or when the ground is covered with snow.
- Holidays
 - Religious observations such as Ramadan or Christmas may make people less likely to participate in the study.
 - Vacation times when many people may be away can also influence enrolment.
- Work schedules
 - More families may be home on weekends or early evening if many mothers work.

Field team composition

- Gender
 - In some cultures women cannot be interviewed by men they are not related to.
- Language
 - Field teams should predominantly be composed of staff who speak the language/dialect of the study participants.
- Experience
 - Field team leaders and investigators should have some field study experience but not necessarily related to lead.

Safety and comfort

- Clothing should be
 - Business casual and not too revealing.
 - Appropriate for climate; e.g., high or low temperatures, high humidity. Consider the need for sunscreen, insect repellants.
- Universal precautions for sample collection and handling samples
 - Train all staff, even if not primarily responsible for sample handling.
- Security
 - Seek advice about local security concerns.
 - Notify local law enforcement as appropriate about locations of field teams.

Instructor Notes:

Clothing: Field teams should use sunscreen and wear light, breathable, business casual clothing if temperatures can exceed 80°F. Staff should avoid wearing clothing with slogans or logos. Each fieldworker should be given a badge with identifying information.

Precautions: All team members, whether or not they are responsible for blood drawing, should be trained in the safe handling of biologic specimens.

Security: Let local police and authorities know when and where field teams will be on a given day.

Health education messages

- Exposure to lead can seriously harm a child's health. Young children are particularly vulnerable to exposure from lead because of their hand to mouth activity and because they play in garden areas where lead can be in the soil.
- Exposure to lead can cause: Damage to the brain and nervous system; slowed growth and development; learning and behavior problems; hearing and speech problems
- Lead can be found throughout a child's environment from the following sources
 - If the source is known or strongly suspected that source should be highlighted in the messages; for example:
 - How does lead get from the soil into your child?
 - Lead in dirt clings to fingers, toys and other objects that children normally put into their mouths. This is the most common way that lead in soil gets into your child. Lead in soil does not pass through unbroken skin. The more lead that is in your soil, the more harmful the soil can be to your children's health.
- The good news; lead poisoning is 100% preventable.

Instructor Note: Messages should be developed that are specific to the study site but typically contain the information in this slide. Messages should be written at the lowest literacy level possible. All field team members should be trained to provide this information

Sample collection and analysis considerations - outline

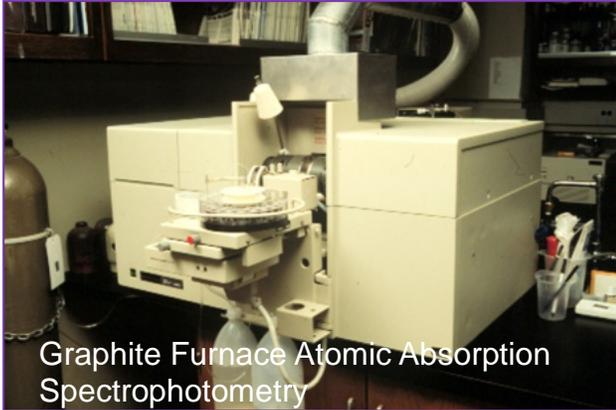
The next few sections discuss the following sample-related considerations:

- Blood sample collection techniques
- Analytic instruments
- Quality assurance and control

Blood collection and laboratory methods

- Capillary vs. venous samples.
- LeadCare II portable blood lead analyzer uses capillary or venous samples and gives a result within a few minutes.
- Bench laboratory methods can cover a wider range of blood lead values but there is usually a wait for the results.
- Adequate quality control is essential.
- Additional information is provided in Module C.i.

Examples of analytical equipment



Instructor Note:

Graphite Furnace Atomic Absorption Spectrophotometry: Good detection limit $<1-2 \mu\text{g/dL}$; requires some laboratory expertise.

Inductively Coupled Plasma Mass Spectrometry: Excellent detection $<0.1 \mu\text{g/dL}$; requires considerable laboratory expertise.

LeadCare I: No longer being produced but still supported by manufacturer; proficiency testing required in the United States.

LeadCare II: Proficiency testing not required by the U.S. Food and Drug Administration. Detection range $3.3-64 \mu\text{g/dL}$. For samples $\geq 65 \mu\text{g/dL}$ a dilution procedure is available (Neri et al. 2014).

Laboratory quality assurance - LAMP

- A voluntary program that focuses on assuring the quality of blood lead, cadmium, and mercury levels.
- Each quarter CDC provides blood samples that are analyzed by participating laboratories who return the results to CDC.
- CDC provides detailed reports on the laboratories about how well they performed these analyses.
- No charge for participation.



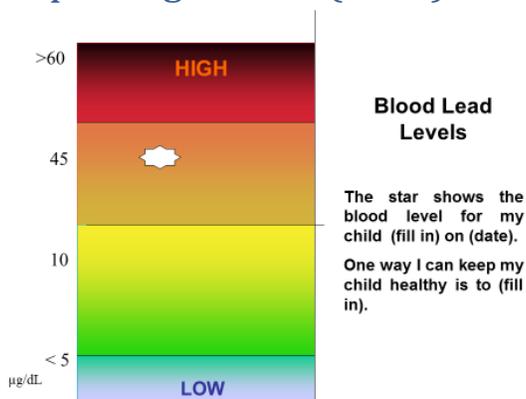
Centers for Disease Control and Prevention (CDC)
Lead and Multi-Element Proficiency
4770 Buford Highway N.E., Mailstop F-18
Atlanta, GA 30341-3724 USA

Fax number: (770) 488-4097
E-mail address: LAMP@cdc.gov

Reporting results

- Parents/guardians
 - Explain blood lead test results in person within 72 hours of blood draw including any necessary follow-up.
 - Report environmental samples to parents/guardian as soon as they are available (they usually take longer to analyze).
- Health care provider
 - Report blood test results to the health care provider as quickly as possible after notification of parents/guardians.
 - Consider very high BLLs ($\geq 65 \mu\text{g/dL}$) an emergency.
- Confidentiality: All individualized test results are private and cannot be shared with anyone other than parents or health care providers.

Reporting results (cont.)



Blood lead follow up

U.S. CDC recommended actions based on BLL (Reference C.iii.13)

<Reference Value	≥Reference Value ≤45 µg/dL	≥45 to ≤69 µg/dL	≥70 µg/dL
Lead education -Dietary -Environmental	Lead education -Dietary -Environmental	Lead education -Dietary -Environmental	Hospitalize and commence chelation therapy (following confirmatory venous blood lead test) in conjunction with consultation from a medical toxicologist or a pediatric environmental health specialty unit
Environmental assessment* for pre-1978 housing	Follow-up blood lead monitoring	Follow-up blood lead monitoring	
Follow-up blood lead monitoring (see pages 23–24)	Complete history and physical exam	Complete history and physical exam	Proceed according to actions for 45–69 µg/dL
	Lab work: - Iron status Consider hemoglobin or hematocrit	Lab work: -Hemoglobin or hematocrit -Iron status -Free erythrocyte protoporphyrin	
	Environmental investigation Lead hazard reduction	Environmental investigation Lead hazard reduction	
	Neurodevelopmental monitoring	Neurodevelopmental monitoring	
	-Abdominal X-ray (if particulate lead ingestion is suspected) with bowel decontamination if indicated	Abdominal X-ray with bowel decontamination if indicated	
		Oral chelation therapy Consider hospitalization if lead-safe environment cannot be assured	

The scope of an environmental assessment will vary based on local resources and site conditions. However, this would include at a minimum a visual assessment of paint and housing conditions, but may also include testing of paint, soil, dust, water, and other lead sources discussed previously. This may also include looking for exposure from imported cosmetics, pottery, food, toys, etc., which may be more important with low-level lead exposure.

Risk vs. benefit of participating in a prevalence study

- There is minimal risk from blood draw.
- Parents/guardians benefit by being informed of their child's blood lead status.
- Knowing that a BLL is high can then trigger other services; e.g., education, environmental assessment, medical treatment and follow up, and social services.
- Data from studies can inform policy decisions to control or eliminate lead in children's environment

Other study benefits

- Opportunity to incorporate other public health topics of interest such as immunization status, housing conditions, or nutritional assessment to the blood lead prevalence survey.
- Opportunity to distribute educational material.

Conclusions

- Conducting blood lead prevalence studies provides information to identify whether and where lead exposure is occurring.
- These studies should be carried out in a scientifically rigorous manner.
- The results of prevalence studies can be used to target lead poisoning prevention and other public health interventions.

References

Based on a presentation made at the Global Alliance to Eliminate Lead Paint Workshop on Establishing Legal Limits on Lead in Paint, 22–23 September 2014, New Delhi, India. Adapted for inclusion in the Lead Paint Alliance Toolkit for Governments, April 2015.

C.iii.1. Meyer PA, Brown MJ, Falk H. 2008. Global approach to reducing lead exposure and poisoning. *Mutat Res* 659(1–2):166–75.

Ciii.2. U.S. Department of Housing and Urban Development. 2011 American Healthy Homes Survey: lead and arsenic findings. Available from

URL: http://portal.hud.gov/hudportal/documents/huddoc?id=AHHS_REPORT.pdf [accessed 2016 Aug 5].

C.iii.3. Fleming IW. Every dot is a Detroit child with lead poisoning. *Detroit Free Press*, 21 January 2003.

C.iii.4 U.S. Centers for Disease Control and Prevention. Unpublished data.

C.iii.5 U.S. Centers for Disease Control and Prevention. Unpublished data.

C.iii.6 U.S. Centers for Disease Control and Prevention. Unpublished data.

C.iii.7 U.S. Centers for Disease Control and Prevention. Unpublished data.

C.iii.8. Brown MJ, Falk H. 2015 U.S. Centers for Disease Control and Prevention, personal communication.

C.iii.9. Dooyema CA, Neri A, Lo Y-C, Durant J, Dargan PI, Swarthout T, et al. 2012. Outbreak of fatal childhood lead poisoning related to artisanal gold mining in northwestern Nigeria, 2010. Environ Health Perspect 120:601–7. <http://ehp.niehs.nih.gov/1103965/>

C.iii.10. Dignam T, Rivera Garcia, DeLeon M, Curtis G, Creanga AA, Azofeifa A, et al. 2015. Prevalence of elevated blood lead levels and risk factors among residents younger than 6 years, Puerto Rico—2010. J Publ Health Manage Pract. doi: 10.1097/PHH.0000000000000224.

C.iii.11. LandScan, http://web.ornl.gov/sci/landscan/landscan_data_avail.shtml

C.iii.12. Power and Precision, www.power-analysis.com

C.iii.13. Advisory Committee on Childhood Lead Poisoning Prevention of the Centers for Disease Control and Prevention. 2012. Low level lead exposure harms children: A renewed call for primary prevention. Available from URL: http://www.cdc.gov/nceh/lead/acclpp/final_document_030712.pdf [accessed 2016 Aug 4].

Additional sources

Module Cii: Analytical Methods for Measuring Lead in Blood.

U.S. Centers for Disease Control and Prevention. 2004. Using GIS to assess and direct childhood lead poisoning prevention: Guidance for State and local childhood lead poisoning prevention programs, <http://www.cdc.gov/nceh/lead/publications/UsingGIS.pdf>

Field Technical Guide (CDC publication; not cleared).

U.S. Centers for Disease Control and Prevention. 2008. LAMP: CDC's Lead and Multi-Element Proficiency Program, http://www.cdc.gov/labstandards/pdf/lamp/LAMP_Factsheet.pdf

National Environmental Methods Index, <https://www.nemi.gov/home/>

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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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