Health Consultation

Exposure Investigation Report

LEAD IN INDOOR DUST, OUTDOOR SOIL, AND BLOOD
OF LINCOLN PARK NEIGHBORHOOD RESIDENTS

FREMONT COUNTY, COLORADO

EPA FACILITY ID: COD042167858

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared by:

The U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation

Acknowledgement

The Exposure Investigation described in this document was a collaborative effort that included significant contributions from the United States Environmental Protection Agency (EPA) and a local community group, the Colorado Citizens Against Toxic Waste. The Agency for Toxic Substances and Disease Registry acknowledges the support of both the EPA and the Colorado Citizens Against Toxic Waste during the planning and execution of the Exposure Investigation.

Abbreviations and Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
ATSDR	Agency for Toxic Substances and Disease Registry
BLL	Blood lead level
CDC	Centers for Disease Control and Prevention
CCAT	Colorado Citizens Against Toxic Waste
EI	Exposure Investigation
EPA	U.S. Environmental Protection Agency
NCEH	National Center for Environmental Health (CDC)
QA/QC	Quality assurance/ Quality control
µg/dL	micrograms per deciliter

Executive Summary

Based on community concerns and a request for assistance from the United States Environmental Protection Agency (EPA), the Agency for Toxic Substances and Disease Registry (ATSDR) assessed lead contamination in the Lincoln Park neighborhood, located just south of Canon City, Colorado.

ATSDR reviewed available lead data and concluded that both the characterization of levels of lead in samples of in-home dust, and the estimates obtained from a computer model, generated concerns related to possible lead exposures in the Lincoln Park neighborhood. Collectively, this information suggested that exposures to the lead in dust could impact the health of children residing at properties in the Lincoln Park neighborhood. Therefore, ATSDR concluded that the lead in house dust in the Lincoln Park area represented an indeterminate health hazard and recommended an exposure investigation (EI) to address unanswered questions.

To assess the health impact from lead in the Lincoln Park neighborhood, an EI was conducted in September and October 2005. The EI was a collaborative effort including ATSDR, a local community group, the Colorado Citizens against Toxic Waste, and the EPA. The EI analyzed samples for lead in indoor dust, blood, and soil at selected households in the Lincoln Park neighborhood.

Summarized information collected by the EI is as follows:

A total of 21 households from the Lincoln Park neighborhood participated in this investigation for indoor house dust testing and blood testing for lead.

None of the adults or children in the households tested in this investigation had elevated blood lead levels.

All of the in-home dust samples (total samples = 44) were below a 95^{th} percentile reference value, and all but two in-home dust samples were below a median reference value. All but one of the in-home dust samples was below a health-based reference value.

Soil lead was analyzed at 15 of the properties that ATSDR tested for in-home dust lead levels. None of the soil lead levels exceeded the reference value used to evaluate residential soil lead levels.

The EI results from the Lincoln Park neighborhood did not indicate the presence of unusual levels of lead in residential indoor dust samples, the soil at those homes, or in the blood of occupants of those homes.

Background

Canon City, located in Fremont County, Colorado, is the historical home of numerous milling and smelting facilities. One facility, the Cotter Mill, currently mills uranium ores. Residents of the Lincoln Park neighborhood (located just south of Canon City) expressed concerns regarding potential contamination, in particular lead, associated with these operations. In response to these questions and concerns, the Environmental Protection Agency (EPA) compiled the available data describing lead contamination in the Canon City area. At the request of EPA and the community, the Agency for Toxic Substances and Disease Registry (ATSDR) reviewed the available lead data and concluded that both the characterization of levels of lead in samples of in-home dust, and the estimates obtained from a computer model, generated concerns related to possible lead exposures in the Lincoln Park neighborhood [ATSDR 2005a,b]. This information suggested that exposures to the lead in dust could impact the health of children residing at properties in the Lincoln Park neighborhood. Therefore, ATSDR concluded that the house dust lead levels in the Lincoln Park area represent an indeterminate health hazard and recommended an exposure investigation (EI) to address unanswered questions.

An elevated blood lead level (BLL) in children affects their cognitive and behavioral development [CDC 2002]. Elevated BLLs in children have been associated with growth impairment, high blood pressure, hearing problems, and slowed nerve conduction [NRC, 1993]. Children are also more likely to be exposed to lead due to pica behavior, poor personal hygiene and more frequent contact with soil during play activities. The likelihood of lead exposure increases among children with multiple risk factors. The primary risk factors include low socioeconomic status or poverty, immigrant status, and living in older housing [CDC 2000, Pirkle 1998].

Although children are at greatest risk from lead exposure, adult exposures can also occur. Most adult exposures are work-related. Exposures to workers occur in smelting, refining, and manufacturing industries. A worker may inhale lead dust and lead oxide fumes, as well as eat, drink, and smoke in or near contaminated areas, thereby increasing their probability of lead exposure [ATSDR 2000]. If showers and changes of clothing are not provided at work, workers can bring lead dust home on their skin, shoes, and clothing, and inadvertently expose family members. Adults can also be exposed from certain hobbies and activities where lead is used. For example, lead exposure can occur during renovation or removal of lead paint, from certain lead-containing cosmetics (non-Western), and use of home health remedies [ATSDR 2000]. Excluding the developmental effects unique to young children, the health effects experienced from adult exposures are similar to those experienced by children, although the levels at which these health effects are usually higher for adults [ATSDR 2000].

To assess the health impact from lead in the Lincoln Park neighborhood, an EI was conducted in September and October of 2005. The EI focused on gathering data that were used to evaluate exposures to lead. The samples evaluated included indoor dust, soil from homes where dust was sampled, and blood from occupants of those homes.

The results from those tests, an evaluation of the results, and the conclusions derived from the data are presented in this report.

Methods

Investigators/Collaborators

The EI was a collaborative effort that included ATSDR, EPA, and a local community group, the Colorado Citizens Against Toxic Waste (CCAT).

ATSDR conducted the in-home dust sampling and the blood lead sampling. A contracted analytical laboratory analyzed the lead in dust samples and the laboratory at the National Center for Environmental Health (NCEH) analyzed the blood samples.

The EPA, through a contractor, collected soil samples from most of the properties where ATSDR conducted lead sampling of indoor dust and residents' blood. EPA provided the results from those soil samples to ATSDR, and a summary of those soil results is presented in this health consultation.

The CCAT provided information to members of the Lincoln Park neighborhood in a "door-to-door" campaign, and collected a list of persons with an initial interest in participating in the EI. Representatives from ATSDR made subsequent contact with the interested households and selected a convenience sample for participation in the EI.

Target Population

The homes and occupants from 21 households in the Lincoln Park neighborhood were tested in this EI. Preference for inclusion in the EI was given to families with young children. All occupants of the household (adults and children) were offered blood lead testing. A total of 45 participants from these households agreed to be tested for blood lead. Three of the samples did not pass quality control criteria and were not analyzed. Figure 1 illustrates the approximate locations of the households tested. Points illustrating addresses are intentionally shifted in a random manner to protect the confidentiality of participants.

Samples

Environmental samples - House Dust

During the week of September 19th, 2005, ATSDR representatives obtained 44 indoor dust samples from 21 households in the Lincoln Park neighborhood. Indoor dust samples were analyzed for lead. The indoor dust samples were collected using a HEPA vacuum (Omega Vac; Atrix International, Inc.) in two high traffic areas within the house. Four samples were obtained from one house, and two samples were taken from all other homes. The sampling locations were identified by household members with an emphasis on collecting samples where children frequently play. Dust was collected from a one square meter area that was thoroughly vacuumed. The samples were sieved to remove large debris prior to analysis. The samples were analyzed at the Federal Occupational Health Environmental Laboratory in Chicago, IL. The samples were microwave digested and analyzed by atomic absorption spectrometry. The method limit of detection was 25 ppm.

House dust results greater than 380 ppm were considered elevated. The 380 ppm reference value is discussed in detail in a previous health consultation (ATSDR, 2006b). This value was developed using site specific data and the Integrated Exposure Uptake Biokinetic Model that EPA developed to estimate lead exposures that may lead to elevated BLLs. The value of 380 ppm is similar to the 400 ppm concentration typically used in evaluating risks associated with soil lead exposures. In-home dust samples were also evaluated using data gathered in a study the EPA conducted on dust in homes located in the Midwestern area of the United States [Clayton, 2002]

Environmental Samples – Soil

Composite soil samples were taken in various locations on the 22 properties and included samples from childrens' play areas. A total of 80 soil samples were collected and analyzed for lead content. Typical samples were taken at depths of 0-2 or 0-6 inches. The samples were analyzed by Inductively Coupled Plasma Atomic Absorption (USEPA method SW-846; Method 6010-soils) and by X-Ray Fluorescence. EPA provided the soil data to ATSDR and the information are summarized in this report. (Complete details of the EPA sampling and analysis protocols and the results are provided in: Residential Soils Sampling Project: Lincoln Park CERCLA Site. January 25, 2006. United States Environmental Protection Agency Region 8. Prepared by: Frontier Environmental Services, Inc. Wheat Ridge, CO. 80033. [EPA, 2006])

Soil lead levels were evaluated using a reference value of 400 ppm, a value commonly used to evaluate lead in soil of residential properties. Soil lead levels exceeding 400 ppm were considered elevated.

Biological Samples - Blood

During the week of September 19th, 2005, ATSDR representatives obtained 45 blood samples from the 21 households that participated. Three samples did not meet QA/QC criteria and therefore were not analyzed by the lab. The capillary blood samples were collected using a "finger stick" method and were analyzed for lead by the NCEH lab in Atlanta, Georgia. The lead content was analyzed by using a Perkin Elmer Model 5100 atomic absorption spectrophotometer with Zeeman effect background correction. The lower limit of detection for this method is 0.6 µg/dL. Results were reported as micrograms of lead per deciliter of blood (µg/dL).

Blood lead concentrations greater than or equal to 10 µg/dL in children are considered elevated [CDC 1991]. American Conference of Governmental Industrial Hygienists (ACGIH) guidelines were used to evaluate blood lead concentrations in adult participants 16 years or older. Based on ACGIH's biological exposure indices, participants with potential occupational exposures and blood lead levels greater than or equal to 30 µg/dL are considered to have elevated exposure to lead.

Data Management

Blood lead results and dust lead results were electronically transmitted from the analytical laboratories to ATSDR in spreadsheet format. No personal identifiers were included in the spreadsheet. Data quality assurance and quality control were performed by the analytical laboratories.

Data Reporting

In May 2006, individual test results (biological and environmental) and an explanation of their significance were provided to the participants of this investigation. Upon request, an ATSDR physician was available via telephone to discuss participants' results. Individual test results were not made available to the public, and confidentiality was protected according to Federal and State laws. This report does not reveal personal identifiers.

Results and Discussion

Environmental Samples – House Dust

All but one of the 44 in-home dust samples were below the health-based reference value of 380 ppm that was used to evaluate the in-home dust lead concentrations. In the case of the highest value (637 ppm), the second room tested in that house had a lead in dust concentration of 25 ppm or less. The second highest in-home dust level found in the EI was 225 ppm. The second room tested in that house had a dust concentration of 25 ppm or less.

All of the dust samples from the EI were below a 95^{th} percentile level (1176 ppm) that was reported by the EPA for a study of 245 homes in the Midwestern area of the United States. All but two of the in-home dust levels found in the EI had dust concentrations that were below the median level (134 ppm) from that EPA study [Clayton, 2002].

These data indicate that the households that participated in the EI did not contain unusual levels of lead in the in-home dust.

Environmental Samples - Soil

Eighty samples were taken at 22 properties; 15 of those properties were also tested by ATSDR for in-home dust lead levels. All of the lead levels in the soil samples ranged between 11 and 260 ppm. The two highest soil lead levels were 220 and 260 ppm; all other soil lead levels were 200 ppm or less. The average soil lead level was 94 ppm (standard deviation = 56). (Complete details of the USEPA sampling and analysis protocols and the results are provided in: Residential Soils Sampling Project: Lincoln Park CERCLA Site. January 25, 2006. United States Environmental Protection Agency Region 8. Prepared by: Frontier Environmental Services, Inc. Wheat Ridge, CO. 80033 [EPA, 2006].

All of the soil lead levels were well below the 400 ppm reference value used to evaluate soil lead levels in residential areas. This finding indicates that soil lead levels in the yards that were tested in this EI do not contain unusual levels of lead.

Biological Samples – Blood

Adults

Of the 42 blood lead samples analyzed, 30 were adults. Age, gender and ethnicity data for the adults who participated in this investigation were not available. Blood lead concentrations greater than or equal to 30 µg/dL are considered elevated in adults. Table 1 shows the summary statistics for the adults tested in this investigation. None of the adults in this investigation had blood lead levels above 30 µg/dL indicating that there were no unusual lead exposures. In fact, all the adults in this investigation had BLLs below 10 µg/dL, the exposure limit for children. Based on the data collected in this investigation, there appears to be no evidence of unusual lead exposure among adults tested in this investigation.

Table 1. Blood Lead Levels in Adults.

Statistic	Value (ug/dL)
Mean	2.01
Median	1.60
Range	0.7 – 7.9

µg/dL = micrograms per deciliter

Children

Of the 42 blood lead samples tested, 12 were children. All children tested at their homes were between 1 and 12 years of age (3 of the children were 6 years of age or less). The average age of child participants was 8 years and the median age was 8.5 years. Gender and ethnicity data for the children who participated in this investigation were not available.

Blood lead concentrations greater than or equal to 10 µg/dL are considered elevated in participants younger than 6 years of age [CDC, 1991]. None of the children in this investigation, including those older than 6 years of age, had blood lead levels above 10 µg/dL and therefore did not have unusual exposure to lead. Table 2 shows the summary for BLLs for the children tested in this investigation.

Table 2. Blood Lead Levels in Children

Statistic	Value (ug/dL)
Mean	1.85
Median	1.8
Range	1.2 – 2.7

µg/dL = micrograms per deciliter

Comparison of Blood Lead Levels to U.S. General Population

The BLLs in this investigation were also compared to the 95th percentile value for the civilian U.S. population, as reported in the Centers for Disease Control and Prevention's (CDC) *Third National Report on Human Exposure to Environmental Chemicals* [CDC 2005]. This report provides information on BLLs in the general U.S. population; these levels are *not* levels at which health effects are likely. The CDC National Report merely states how much lead is in the blood of most people who are not *unusually* exposed to lead. The participants in the investigation were compared to the data collected in the U.S. population during the years of 2001-2002.

Adults

All but two of the BLLs in this investigation were below the 95% of the U.S. population for adults 20 years and older (95th percentile = 4.80 µg/dL). The two adults with BLLs above the 95th percentile for adults 20 years and older, had BLLs of 5.4 and 7.9 µg/dL. This is not unexpected since a small percentage of participants are expected to lie outside the 95 percentile. In addition, these levels still remain below 10 µg/dL (the child exposure limit) and 30 µg/dL (the adult exposure limit) and therefore do not indicate unusual exposure to lead. Thus, the majority of adult BLLs in this investigation remain below national levels. The number of adults tested in this investigation is small and does not represent all the households in the area.

Children

All of the BLLs for children in this investigation were below the 95% of the U.S. population for their respective age group. Table 3 depicts the 95th percentile levels for children in the U.S. population compared to children in this investigation. Thus the children in this investigation had BLLs below the national level and these levels were also well below 10 µg/dL.

Table 3. Comparisons of Blood Lead Levels with the U.S. population

Age Group	95th percentile reference value for lead in U.S. population (2001-2002)	Number of children in this investigation above 95th percentile
1-5 years	5.80 µg/dL	None
6-11 years	3.70 µg/dL	None
12- 19 years	2.70 µg/dL	None

µg/dL = micrograms per deciliter

The number of children tested in this investigation remains small and does not represent all the households in the area. However, a concurrent ATSDR investigation of BLLs in young children in the area did not find evidence of unusual lead exposure. At risk children had blood lead testing at a local school and no unusual lead exposure was detected in this group [ATSDR June 2006c].

In this investigation, adults and children were selected for blood lead testing in the Lincoln Park neighborhood because of a potential risk of increased exposure to lead in the area. None of the adults and children in this investigation had BLLs of concern. Although only selected households were tested for indoor dust and blood lead, the EI did not reveal evidence of unusual exposures to lead in the Lincoln Park neighborhood.

Conclusions

1. Based on the blood lead levels collected during the EI, neither the adults nor children participating in the EI of homes in the Lincoln Park neighborhood had unusual exposures to lead. The blood lead levels found in the occupants of the homes do not represent a public health concern.

2. Based on the lead in dust data collected during the EI, none of the households that participated in the EI had unusual levels of lead in the in-home dust. The levels of lead found in the in the dust at the participating homes do not represent a public health concern.

3. Based on the lead in soil data collected by the EPA, none of the properties that participated in the EI had unusual levels of lead in the soil in their yards. The levels of lead found in soil at the participating homes do not represent a public health concern.

Recommendation

No recommendations related to lead in dust in homes are needed. However, routine monitoring of children's blood lead levels in the Lincoln Park neighborhood, as well as the surrounding area, should continue.

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Figure 1. Approximate Locations of Homes Sampled for Lead in Dust. The portion of the map shaded in pink illustrates the general area of the Lincoln Park neighborhood. Several of the single points noted on the map represent multiple sample locations of near-neighbors.