FINAL REPORT

Agency for Toxic Substances and Disease Registry

Jasper County, Missouri Superfund Site Childhood 2000 Lead Exposure Study

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ABSTRACT

The purpose of this study was to determine whether intervention efforts initiated in Jasper County, Missouri since the 1991 Jasper County, Missouri Superfund Site Lead and Cadmium Study have been effective in reducing the mean blood lead levels of children residing in the area. The mean blood lead levels for the 1991 study was 6.24 ± 4.86 μg/dl and for the 2000 study was 3.82 ± 2.29 μg/dl in children living in the same geographical area as the 1991 study. Blood lead levels declined on average by 2.42 μg/dl between 1991 and 2000. The proportion of children with blood lead levels greater than or equal to 10 μg/dl in the 1991 study was 14% and in children living in the same area as the 1991 study was 2% in the 2000 study.

The results of this study indicated that educational and environmental interventions initiated since 1991 to reduce blood lead levels of children living in the mining waste and smelter area of Jasper County, Missouri have been effective. Only two percent of the children tested in 2000 had blood lead levels greater than 10 μg/dl.

INTRODUCTION

RATIONALE FOR STUDY

This study was conducted to evaluate the effectiveness of environmental and health educational interventions to reduce childhood lead poisoning in the Jasper County Superfund site. The study compares blood lead and environmental data collected in the 1991 Jasper County, Missouri Superfund Site Lead and Cadmium Exposure Study to data collected in a new cohort of children who should have benefited from these interventions.

The 1991 exposure study was funded by the Environmental Protection Agency EPA) through an interagency agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).[1] This study examined blood lead levels and urine cadmium levels in people living in areas affected by the past mining activities at the Jasper County Superfund Site compared to a control group of people living in an area where no lead mining related activities occurred. Children between the ages of 6 and 72 months, youth, and adults were evaluated.

Urine cadmium levels did not significantly differ between the control and study populations and only children were found to have blood lead levels higher than controls. Mean blood lead levels were almost twice as high in children living in the study area as compared to those in the control area [6.25 ± 4.86(SD) and 3.59 ± 1.88 μg/dl]. As a result, 14% of the study children had blood lead levels ≥ 10 μg/dl, the level set by the Centers for Disease Control and Prevention (CDC) at which intervention was required. None of the children in the control area had elevated levels.

The mean blood lead levels in the study group remained significantly higher than those in the control area after adjustment for behavioral, demographic, and socio-economic variables. After we controlled for dust, soil, water and indoor paint lead levels, the differences disappeared, suggesting that environmental factors accounted for the differences in blood lead levels.

Since the release of the results, major intervention efforts at the Jasper County Superfund site have been initiated with the goal of reducing the mean blood lead levels of all children and thereby reducing the proportion of children with elevated blood lead levels. The major interventions were replacement of lead contaminated soil in residential and day care yards and an aggressive community education campaign. As of June 2000, EPA had remediated 2,288 residential yards. An additional 51 homes were remediated as of October 18, 2001. The health education campaign incorporated lead poisoning awareness in local school curricula, published site-specific coloring/story books, and developed a lead poisoning prevention merit badge for a local Girl Scouts' chapter. In addition, educators made presentations at grand rounds in area hospitals, and distributed flyers, magnets, and other materials to raise awareness about childhood lead poisoning and its prevention.

In addition to the soil removal, the EPA currently provides funding for lead education, outreach, and expanded blood-lead screening activities among children in the area around the Jasper County site. Furthermore, funds from a U.S. Department of Housing and Urban Development (HUD) grant were used to increase the number of lead screenings and to address lead hazards in homes of children with elevated blood-lead levels. Prior to the study reported here, there had been no systematic attempt to evaluate the effectiveness of these lead intervention programs. While both programs have funded lead screening, screening cannot answer the question of whether the interventions have been effective in reducing lead poisoning of children living in this community. Screenings are not random but are skewed to high-risk children. The 1991 exposure study was conducted on a random sampling of the population prior to the interventions. The current study replicated the 1991 study by examining a random sampling of eligible children from the same area as the 1991 study nine years after the 1991 study was completed.

The 1991 study evaluated children, youth, and adults. Children were found to be at highest risk for lead exposure, therefore, only children six to 72 months of age were selected for the current study. This age period is when children exhibit considerable hand-to-mouth behavior.

Study Hypotheses

1. The prevalence of elevated blood lead levels of children living in the Jasper County lead mining area in 2000 will be lower than prevalence levels determined in children living in the same geographical area during the 1991 exposure study.

2. The mean blood lead levels of children living in the Jasper County lead mining area in 2000 will be lower than mean blood lead levels determined in children living in the same geographical area during a 1991 exposure study.

3. Average environmental lead levels in 2000 will be lower than those reported in homes in the same geographical area in1991.

Study Objectives

The objectives of this study were to evaluate the effectiveness of the soil remediation activities of EPA and the public health remedial actions of local public health officials by:

1. Measuring exposure to lead by analyzing blood from Jasper County children.
2. Comparing blood lead levels between the 1991 and the 2000 study.
3. Measuring environmental sources of lead.
4. Comparing average environmental lead levels between the1991 and the 2000 study.

5. Evaluating whether recontamination of the remediated yards occurred.
6. Evaluating the relation between blood lead levels and environmental sources of lead.
7. Determining the relation between blood lead levels and behavioral risk factors.

BACKGROUND

PROBLEM STATEMENT

The Jasper County Superfund Site, listed as the Oronogo-Duenweg Mining Belt Site, Jasper County, was added to the National Priorities List in 1990. Jasper County is located in extreme southwest Missouri (See Appendix 1 for area map). The site is part of the Tri-State Mining District, which covers approximately a 2,500-square mile area in southwestern Missouri, southeastern Kansas, and northeastern Oklahoma. Mining, milling, and smelting of Tri-State District lead and zinc ore dates back to 1850 and continued in the district until the 1970's. Mining operations in this region generated several types of waste materials associated with the physical removal and refining of ore from both surface mines and underground mines including mine wastes (non-ore waste rock and overburden), mill wastes (crushed ore wastes and fine tailings), and smelter-related materials (slag, fugitive dust, and air emissions fallout).

Processing of the ore in Jasper County resulted in approximately 150 million tons of waste. Of these, approximately nine million tons remain interspersed unevenly throughout an area of approximately 250 square miles. These wastes have been dispersed over time by both human and natural activities. The wastes contain heavy metals such as lead, cadmium, and zinc. Smelting was conducted at various locations throughout Jasper County during the 1800's. At least 17 major smelters were operating at the site in the late 1800's, mostly in the Joplin, MO area. After the turn of the century, all smelting in Jasper County was conducted at the Eagle-Picher smelter in northwest Joplin. Residential areas of approximately 5,000 homes within the identified zone of contamination surround this smelter, however, EPA has determined that most of the soil contamination is related mill waste except for contamination related to the Eagel-Picher smelter.

The wastes from the mining, milling, and smelting of the ore have significantly contaminated surface soil, surface water, and groundwater. Approximately 470 homes on the eastern side of the site rely on private groundwater wells. The EPA has determined that at least 100 of these wells exceeded health-based action levels for lead and cadmium. At least 2,300 residential yards in northwest Joplin, around the Eagle-Picher smelter, were contaminated with lead above acceptable levels. Additionally, EPA determined that yard soil in approximately 200 homes built on or near milling waste piles exceeded acceptable levels of lead.

Exposures in the study area are due to contact with ambient air dust, indoor house dust, soil, and water. For this study, ingestion of soil, dust, and particulate matter was considered the most relevant exposure pathway.

RELATIONSHIP BETWEEN LEAD EXPOSURE, RISK FACTORS, BLOOD LEAD LEVELS AND HEALTH PROBLEMS

Vulnerability of Children to Lead Exposure

Lead exposure can affect the health of people regardless of gender, age, ethnicity, or socio-economic status. However, lead exposure is most harmful to infants and children. Young children are at the highest risk because of their hand-to-mouth behavior, which increases the likelihood of exposure to lead in paint, dust, and soil. In addition, once lead has entered the intestinal tract, young children tend to absorb it more readily than adults. Lead exposure even at levels as low as 10 μg/dl in children has been shown to affect the brain and nervous system resulting in reduced intelligence and attention span and in learning and behavioral problems.[2] The neurotoxic and other adverse health effects of lead exposure are described below.

Adverse Health Effects In Children

The CDC considers lead poisoning the number one preventable pediatric health problem facing children today.[3] At low levels of exposure, several signs of lead toxicity have been described. Since lead is ubiquitous in the environment, all individuals, particularly children, are exposed.[4] Currently 890,000 children nation wide have blood lead levels greater than 10 μg/dl.[5] Lead has been shown to cause adverse affects between 10-25 μg/dl, with a critical blood level of around 10 μg/dl.[6-11] According to McMichael,[12] a 2-3 point IQ deficit occurs with each 10 μg/dl increment. A recent study by Lanphear et al., suggests deficits in cognitive and academic skills associated with lead exposure occur at blood lead concentrations lower than 5 μg/dL.[13]

The primary pathways of exposure include inhalation of dust particles and ingestion of leaded paint chips. Lead exposure is greatest in indoor dust, where the contaminants are dispersed, trapped, and settled over a confined area.[14,15] In areas with high soil and water lead, these environmental sources also play a significant role in blood lead levels.[1]

Studies have shown that exposure to lead particles is associated with adverse health affects, particularly among individuals exposed to persistent, low-level doses. Possible adverse affects include: delayed reaction time, distractibility, disorganization, impulsivity, restlessness, hypertension, mental and behavioral perturbations such as hyperactivity, violence, learning disabilities, reduced IQ, and diminished attention span.[16-19] Several studies provide evidence that blood lead levels between 10-25 μg/dl adversely affect children's cognition.[20-30]

METHODS

STUDY DESIGN

Children between 6 and 72 months of age living in the study area for at least 60 days prior to the beginning of the study were qualified to participate. In order to recruit children who were most likely to have been exposed to contaminated soil, the study was carried out during summer when children were most likely to have spent time outside. The 1991 study was conducted during this same period. Data from 1991 was compared to data collected during the present study.

STUDY CENSUS

In order to locate children currently living in the study area, a census of all households was conducted. Student workers from Missouri Southern State College (MSSC) were trained on February 9, 2000. Missouri Department of Health (MDOH), MSSC, and Jasper County Health Department (JCHD) representatives participated in the training session. Background information on the site as a former mining area was presented and students were taught how to complete the census form. In addition, the students were taught interview techniques. The training also provided an opportunity for local media to ask questions and report on the study. Local media outlets were helpful in informing the public that students would be working in the area. Police departments from Carterville, Duenweg, Joplin, Oronogo, Webb City, and the Jasper County Sheriff's Department were notified by phone, mail, and fax of the study activities. All students were issued photo identification cards. The mayor of each city was also informed of the activities.

An interview team visited each house and if a respondent was present standard census information was recorded on forms that were entered into a computer base from which a random sample of homes with children would be drawn (see Appendix 2). If there was no response, a minimum of four additional visits were made on different days of the week and at different times of the day.

Repeat census forms were completed on ten percent of the homes with different census takers for quality assurance. All forms were reviewed for accuracy and, if necessary, were followed up with another contact for completion and/or correctness.

SAMPLE SIZE

Data from the 1990 U. S. census was updated to 1996 values using birth and death records to estimate the number of children between the ages of 6 and 72 months in the study area. Using this data, it was estimated that 797 children resided in the study area in 1996. This number was used to approximate the number of children potentially available for this study.

We planned to enroll 350 children into two groups. The first group was a random sample of 250 children from the 1991 study area, (a similar number as in the 1991 exposure study). An additional 100 children from homes in areas affected by smelter activities but outside the 1991 study area was added to gather more information about children living in neighborhoods that may have received soil remediation. This will be referred to as the oversample group. Because this oversample group comes from an area that is not part of the 1991 study, it cannot be used for comparison of blood lead levels from 1991 to 2000.

The 250 children would allow us to detect a decline of 7% in elevated blood lead levels of 10 μg/dl from the 1991 study with a power of .85 and an alpha of .05. We assumed that the standard deviation for this study was similar to that of the 1991 study, therefore, a sample size of 250 would allow us to detect a 2 μg/dl decline in mean blood lead levels at a power of .99 and an alpha of .05. (See Appendix 3).

Sample sizes are calculated to assure that adequate numbers of children are sampled so that the investigators can be reasonably certain that any differences between the 1991 and 2000 study are not the result of chance.

PARTICIPANT SELECTION AND RECRUITMENT

Using the census data, we identified all households with children aged 6-72 months. A list of randomly selected individuals was generated from the computerized census database. Individuals on this list were contacted in an attempt to recruit them into the study.

Recruitment training began on June 12, 2000. Actual recruitment for participants began on June 15, 2000. The first environmental assessment/blood drawing appointments occurred on June 19, 2000. Recruitment contacts were conducted by phone or by door-to-door visits until contact was made, resulting in agreement to participate or refusal. A minimum of eight attempts were made at varying times of day and days of the week. Homes that had new occupants or were found to be vacant were removed from the recruiting list. If no one was home during a door-to-door visit, a note was left explaining the study and requesting that the resident contact the JCHD with a response. Recruitment of the oversample began on August 11, 2000, and the last environmental assessment and blood drawing was completed on October 2, 2000. Recruiting attempts continued into November, however, no home visits occurred because eligible participants did not consent to participate.

Eight homes in the 100 home oversample area received certified letters after multiple attempts to contact them were unsuccessful. These letters were sent on November 26, 2000, and stated that if they did not respond to this last attempt it would be counted as a refusal. No responses were received to these certified letters.

Several problems hindered participant recruitment. A large number of families that had already had their children tested for lead received a negative result, and felt it

unnecessary to retest them. There were also several residences that had new occupants or had been vacated after the census data was obtained. Some eligible participants' phone numbers were disconnected or incorrect. Attempts were followed by several visits to the home by the team. During the course of the study, some people who were successfully contacted made an appointment, and then cancelled or withdrew from the study.

DATA COLLECTION

A team consisting of a pediatric phlebotomist or registered nurse and an environmental specialist went to each home where parents/guardians gave consent to have their child participate in the study. (See Appendix 4). After receiving informed consent, the phlebotomist or registered nurse administered a questionnaire that included information on the child and on the household and then obtained a venous blood sample. Concurrently, the environmental specialist collected environmental samples from the home and yard. Training of professionals conducting home visits took place between June 12, 2000 and June 15, 2000. Study investigators observed questionnaire administration and environmental sampling for two weeks following training and intermittently throughout the study for QA purposes.

INFORMED CONSENT, IRB APPROVAL AND SAFEGUARDS FOR PROTECTING CONFIDENTIALITY OF PARTICIPANTS

This project was reviewed and approved by the MDOH Institutional Review Board (IRB). Identifiers such as child's name were replaced with a unique identification number. This number was used on all forms and data associated with the participant. All data collected from the study and the list of participant identification numbers were placed in a locked file cabinet to protect participants' confidentiality. All participants' parents/guardians signed a consent form prior to initiation of the study. Samples of all consent forms are in Appendix 5.

QUESTIONNAIRE

All participants were administered a survey questionnaire. Parents/guardians were asked to provide questionnaire information for their child. The primary purpose of the questionnaire was to document demographic, behavioral, occupational, and educational information. Behavior that increases risk of exposure to contaminated environmental media and other possible factors related to lead exposure was also documented. The questionnaire included all of the questions from the 1991 Jasper County Exposure Study and several additional assessment questions. The questionnaire contained 116 questions and was completed in approximately 45 minutes. A copy of the questionnaire is included as Appendix 6.

BLOOD LEAD ANALYSIS

Venous blood samples were obtained and analyzed for blood lead levels in accordance with CDC protocols.[31] Blood lead levels were analyzed by the CDC Division of Environmental Health Laboratory Sciences (DEHLS), which is the same lab used in the 1991 study. Each sample received a laboratory identification number and was sent to the laboratory in a blind fashion. The CDC results were used for all analyses. Duplicate blood samples were taken on 10% of the samples and submitted to the MDOH State Public Health Laboratory for analysis. For control of quality in laboratories, duplicate inter-laboratory sample results must be within 20% of each other. All duplicate inter-laboratory samples were within this range. The minimum detection limit for the MDOH laboratory was <5, however, all values were quantified for the CDC laboratory results. All blood lead values reported by the CDC laboratory that were less than 5 μg/dl were also identified by the MDOH Laboratory as less than five. For the 11 values that could be quantified, those greater than 5 μg/dl, the reliability of the blood lead analysis was .99 (Cronbach Alpha). The protocol for blood sampling is Appendix 7.

Attempts to notify participants of elevated blood lead results began as soon as blood lead results were received. Participants were called or visits were made to their homes within three days after the JCHD received results for elevated blood levels of lead. In addition, written results were sent to participants within four weeks after they were received from the laboratory. Sample letters for disclosure of blood lead results to study participants are Appendix 8.

ENVIRONMENTAL SAMPLING AND ANALYSIS

Outdoor soil, drinking water from private wells, and household dust samples were collected for total lead analyses at the residence of each study participant. Selected interior and exterior painted surfaces of each residence that might potentially have been a source of lead exposure to the study population were evaluated for lead content using a portable X-ray fluorescence (XRF) monitor. Quality control (QC) measures were practiced during all procedures.

Written notifications of environmental sampling results were sent to participants within four weeks of the time they were received from the laboratory. Sample letters for disclosure of environmental results to study participants are in Appendix 9.

Sampling protocols for the 2000 study differed from those used in the 1991 study. In the 1991 study, soil lead levels were collected as a composite of the whole yard excluding the drip line. Because we wanted to better characterize the soil lead levels during the 2000 study, composite samples were taken from several locations. Dust samples in the 1991 study were collected using a vacuuming system. Since the 1991 study was completed, this system has been found to be less reliable than dust wipes, therefore, dust wipes in place of vacuuming was used in the 2000 study. In the 1991 study, only indoor paint levels were measured while in the 2000 study both indoor and outdoor paint levels were measured.

SAMPLING PROTOCOLS

All personnel wore disposable gloves when collecting samples, and changed gloves between collections of different sample types. Outdoor soil and indoor dust wipe samples were collected and stored in 50 ml centrifuge tubes with screw tops (or equivalent). Samples were numbered in consecutive order on pre-printed labels. Sample identification number, descriptions, and source of all samples were recorded in project log sheets at the time of sampling. Only the sample numbers were coded on the sample chain-of-custody form (Appendix 10). These were the only identifier available for the laboratory. Environmental sampling protocols are in Appendix 11.

Sampling Locations

Three composite outdoor soil sample types were collected. These represented the general yard non-play area, dripline area within three feet of structure walls, and yard primary play area of the child. General yard area (non-play area) soil samples assessed environmental sources other than exterior paint that may have contained lead. Samples from the dripline determine the contribution of exterior lead paint and from other sources such as ambient airborne particulate sources which may have impacted the house structure and washed off with precipitation. Samples from the child's primary play area assessed site-specific exposure potential.

The interior of the home was evaluated for lead paint and lead dust levels. Indoor testing locations were the child's bedroom, child's main play area, and kitchen. Children's bedrooms and main play areas have been evaluated in past investigations and results suggest these rooms may be high risk areas for exposure to lead if it is present. [32] The main play area has been found to consist of three possible areas that differ from house to house: a separate play room, living room or family room. The kitchen was added as a third location based on previous investigations that suggested this room is a location where young children spend significant time, and because they engage in hand to mouth exposure through food items. Individual dust wipe samples were obtained in each room from one windowsill, one vinyl miniblind (if present), and the floor. Lead-based paint determination was performed using an XRF on windows, doors, walls, ceilings and other locations as indicated on Form 110 (See Appendix 12). Outdoor paint from walls, windows, doors and porches as shown in Form 120 (See Appendix 12) was evaluated for each residence. The physical condition of each painted surface tested was noted.

Drinking water from the kitchen faucet was tested for lead in those homes supplied from private wells (See Appendix 11). The previous study did not indicate exposure to lead through public water sources.

SAMPLE ANALYSIS METHODS

Inductively coupled plasma (ICP) or atomic absorption (AA) sprectrophotometry was used by TC Analytics and Metropolitan Laboratories of Norfok, VA to analyze all soil and dust wipe samples for total lead content (Table 1). The MDOH Laboratory tested water samples.

QUALITY CONTROL MEASURES

The laboratories performing environmental soil and dust wipe analysis and/or preparing quality assurance samples were members of the Environmental Lead Lab Accreditation Program (ELLAP) and were successful participants in the Environmental Lead Proficiency and Analytical Testing (ELPAT) program. Primary quality control (QC) was handled through the use of laboratories with good laboratory practice (Table 2), as evidenced by their accreditation through the AIHA Laboratory Accreditation Program for the ELLAP. In addition, the laboratories participated in the ELPAT program with satisfactory proficiency. For laboratory instrument calibration results outside of the criteria listed in Table 2, all samples within the specific sample batch were re-analyzed. The Quality Assurance protocols are included within each sampling method and are attached in Appendix 11.

Standard Reference Material

Standard reference material samples (SRM's) were inserted into the sampling chain-of-custody protocol in the same manner as field samples to monitor the laboratory's analytical performance (Table 3). These samples also provided laboratory analytic recovery information for assessing the accuracy and precision of field sample data through sample preparation and analysis activities. It should be noted, however, that the accuracy and precision achieved for field samples is partially dependent on the matrix matching between the QC sample and field sample, since analytical results are generally matrix sensitive. It is not possible to completely match the matrix of the field sample. Dust wipe SRM's were prepared using National Institute of Standard Testing (NIST) Lead Paint Dust Standard Powdered Lead Based Paint SRM 2582. Soil SRM's were prepared using NIST Standard Montana Soil SRM 2710 and 2711.

A summary of the SRM (Blind Reference) sample results is shown in Table 3. Actual concentration values obtained are not shown. Instead, the relative percent difference (RPD) between the reported lab results to the expected SRM concentrations is reported. The analysis of blind reference materials showed good recovery and accuracy by the laboratories. An accepted RPD for SRM samples of this type is from 25% to 30% of the expected value. The mean RPD and confidence limits for the SRM's dust wipe samples falls within this range. Although the mean soil SRM results are less than 30%, the 95% upper confidence limit slightly exceeds this (31.8%). Values above an RPD of 30% were not consistently reported, and the differences in real values were low. Overall

SRM RPD's are acceptable. The overall intended frequency of SRM submissions of soil was achieved, and was exceeded for dust wipes.

An additional laboratory check was performed on a subset of soil samples. Both laboratories analyzed a second aliquot of 20 randomly selected soil samples. The results are shown in Table 3. These are real world samples with varying substrate consistency within a sample, and not a uniform substrate such as the SRM's, and a greater variation between laboratory results may be acceptable. Although the variation is somewhat higher than expected (mean - 37.3%), the median was only 16.3%. This overall mean is driven by two outlier values that when removed result in a mean RPD of 20%.

Field Blanks

Field blanks are identical to regular field samples, except that no sample is actually collected. Field blanks provide information on the extent of contamination resulting from a combination of laboratory processing and field handling. The field blank samples were analyzed for lead. A summary of the field blank results is presented in Table 4. Analysis of field blanks indicated no contamination or interference from the field sampling collection media during field use, shipment, and handling. Only two out of 13 glove wipe samples were reported to be above the laboratory reported level of quantification, and except for glove wipe samples, over 90% of all values are below laboratory reported levels of detection. The submission frequency of all field blanks except glove wipes exceeded the intended rate.

DATA ENTRY

A contractor trained in data entry entered all responses to the questionnaire and the environmental sample results into a Statistical Package for Social Sciences (SPSS) database. A 100% recheck of all variables was performed before data analysis was initiated.

DATA ANALYSIS

The Statistical Package for the Social Sciences (SPSS) was used for analysis. Specifically, the statistical analysis was comprised of:

- Descriptive statistics of frequencies, proportions, means, and standard deviations on blood lead, environmental dust, soil and paint, and questionnaire data;
- Calculation of mean blood lead levels between various risk factor groups;
- Correlations between blood lead levels with scaled questionnaire responses and environmental sample results;
- Comparison of mean blood lead between the 1991 and 2000 samples by student t-test and analysis of covariance (ANCOVA) adjusting for potential confounding variables;

- Comparison of questionnaire responses between the 1991 and 2000 studies by chi square and Fisher's exact test for categorical data and t-test for scaled data;
- Comparison of proportion of children with blood lead levels above 10 μg/dl between the two periods using Fisher's exact test;
- Boxplots and error bar graphs of blood lead and environmental data.

All variables were evaluated for normalcy and log transformation of data was performed as needed.

The national trend of declining blood lead levels reported by NHANES was reviewed to assist with interpretation of the decline in blood lead levels found in the 2000 study.[33]

RESULTS

Census Information

All census data was collected and the quality assurance completed by June 2, 2000. Through a total of 17,288 attempted home contacts, the census identified a total of 957 households that reported a child between 6-72 months of age in residence. The response rate for the census data collection was 89.1%, compared to 82% in 1991 (Table 5).

Recruitment Information

Table 6 reports the number of attempts made to contact guardians of eligible children. The percentage of eligible participants who agreed to participate in the 2000 study (34%, Table 7) was similar to the percentage in the 1991 study (36%). Documentation of the reasons eligible participants chose not to participate is given in Table 8.

Descriptive Statistics

Data was collected from a random sample of 215 homes in the same geographical area where the 1991 samples were taken, and from a random sample of 72 homes in the oversample area. However, only 213 and 71 bloods lead levels were obtained from the participants, respectively. This oversample area was included to increase the number of homes that received soil remediation from EPA. Only children living in 215 homes of the 1991 sample area are used for comparison with the 2000 sample because it is not possible to evaluate changes in blood lead levels in areas that were not sampled in 1991. All tables that do not compare results between 1991 and 2000 include data from homes in both the 1991 study area and the oversample area unless otherwise indicated.

Mean blood lead levels of children recruited into the 2000 sample, and mean dust, soil, and paint lead levels of the homes and yards of those children are presented in Table 9. The table shows both homes in the study area and homes from the study area combined with the 72 homes in the oversample area. The values for the study area and oversample area combined were similar to the study area alone.

The cumulative frequency distribution of blood lead levels in 1991 and 2000 for the 1991 sample area is presented in Figure 1. Twenty four percent of the blood lead values were above 5 μg/dl and 2% were above 10 μg/dl in 2000. In the 1991 study, 14% of the blood lead levels were above 10 μg/dl.

Figures 2, 3, and 4 show boxplots of the medians, quartiles, outliers, and extreme cases of indoor dust, soil, and indoor and outdoor paint lead levels, respectively from the 2000 sample for the study and oversample area combined. The box length is the interquartile range. Outliers are cases that fall 1.5 to 3 box lengths from the top and bottom of the box, while extreme cases are greater than 3 box lengths from either end of the box. These plots are a graphical means of indicating the variability in the environmental data. A considerable number of dust, paint, and soil measures were more than three quartiles from the median value, which indicates substantial variation in these measurements. Because of this variation and the skewed nature of the data, environmental data was log transformed before the data was correlated with other data and before it was used in analysis of covariance.

Table 10 lists the proportional responses to categorical items, means and standard deviations for scaled data that were collected via interview during the 2000 study for homes in the study and oversample area combined. The mother of the child completed more than 84% of the questionnaires. Slightly more of the children tested were male than female and most were Caucasian. Only 22% of the children came from households with a family income greater than $40,000. Most of the heads of household had a high school or higher education, and 60% owned their homes. The mother was the head of the household in 30% of the homes. Less than 2% of the homes had lead water pipes, with most having plastic pipes using public water. Almost 40% of the homes had wood exteriors. Within the year prior to the study, 39% of the homes had undergone some type of home repair. Most of the homes were air-conditioned. Only a few individuals had hobbies that would expose them or their household to lead. The most frequent lead related job was auto body repair and maintenance, followed by wire or cable cutting and splicing. Only 3 individuals worked in mining or a mining related job. Approximately half the homes contained a cigarette smoker in the household. Less than 3% of the children breastfed while 25% took a bottle. Fourteen percent of the children played on lead mine waste at least some of the time. A quarter of the children sucked their thumb or fingers and 25% chewed their fingernails. Sixty percent of the children put things other than food in their mouths at least some of the time, but few children put paint chips in their mouths.

Table 11 presents the mean blood lead levels for the questionnaire categories. There were few substantial differences in mean blood lead levels between categories. On average, children living in air conditioned homes had blood lead levels 1 μg/dl lower than children living in non-air conditioned homes. The 19 children living in homes where a family member welded had higher blood lead levels than other children. Children in homes with cigarette smokers also had higher blood lead levels than homes without cigarette smokers.

The univariate relationship between children's blood lead levels and scaled demographic, economic, social, and behavioral factors are indicated by correlation coefficients in Table 12. Younger children have higher blood lead levels than older children. Children in older homes had higher blood lead levels. The more frequently a child's bedroom is cleaned the higher the blood lead level. This might be related to the fact that rooms with more dust require more frequent cleaning. The more often a child plays in dirt compared to grass, the higher their blood lead level rises.

Table 13 shows blood lead levels correlated with log transformed environmental data. Most of the environmental measures were positively associated with blood lead levels. The higher the reported dust, soil, and paint lead levels, the higher the blood lead levels.

Comparison Between 1991 and 2000 Study

Comparisons between the 1991 and 2000 studies are based on data that was collected from the same geographical area for both study times. Data from the oversample area are not included because we only have information from this group in 2000. Figure 5 presents a comparison of mean blood lead levels between the 1991 study and the 2000 study. The mean blood lead level for the 1991 Study was 6.24 ± 4.86 μg/ and for the 2000 Study was 3.82 ± 2.29 μg/dl. Average blood lead levels declined by 2.4 μg/dl between 1991 and 2000 ($p < 0.001$). Mean blood lead levels adjusted (analysis of covariance) for several factors that were significantly different between study periods (family income, education of head of household, if child played in grassy area, and if child took snacks outside) were 6.2 μg/dl for the 1991 study and 3.7 μg/dl for the 2000 study ($p < .001$). The proportion of blood lead levels greater than or equal to 10 μg/dl in the 1991 study was 14% (n=32), and 2% (n=4) in the 2000 study ($p<.001$).

Table 14 compares proportional answers to selected questionnaire data between study periods for children living in the 1991 study area. Children spent significantly more time at a babysitter in the 1991 study than during the 2000 study, but less time in a day care center. Children were more likely to spend time playing in grassy areas in the 2000 study than in the 1991 study.

Environmental data is not directly comparable between the two study periods because the techniques used were different. In the 1991 study, dust lead was reported as an average for the whole house and dust was collected using a vacuum system. In addition, paint lead levels were reported as the average of indoor samples; outdoor

samples were not taken and soil samples were composited from the entire yard excluding the dripline. Most importantly, not all homes were evaluated in 1991. All homes of children with blood lead levels greater than or equal to 10 μg/dl were evaluated and a random sample of other homes were tested. In the 2000 study, all homes received an environmental assessment. Table 15 shows the average environmental findings of the 1991 study.

Evaluation of Soil Remediated Homes During 2000 Study

Table 16 shows the mean blood lead levels of children and environmental measures in homes where the EPA replaced the soil, and homes where soil was not replaced. Although the mean blood lead levels were significantly higher in the children living in homes that received soil remediation ($p<.001$), the indoor and outdoor paint levels were also higher in those homes. In addition, the income level and educational level of the parents living in homes that received soil remediation were lower. Analysis of covariance adjusting for paint lead levels, income, and education levels indicated that there was no significant difference ($p<.59$) between blood lead levels in soil remediated homes compared to non-remediated homes after adjustment. Figure 6 shows boxplots of the soil lead levels in the soil-remediated homes.

Evaluation of the Effects of Household Paint and Soil Levels

Figures 7 through 10 are error bar graphs of blood lead levels for children living in homes that were grouped according to the presence or absence of lead paint inside the home, and according to different soil lead levels. Figure 7 shows blood lead levels in homes that either had or did not have lead paint present, and where the dripline soil lead levels were greater than or less than 800 ppm. Figure 8 is similar to Figure 7, but the dripline soil lead levels were greater than or less than 400 ppm. Figure 9 is for yard soil lead levels greater than or less than 400 ppm. Figure 10 is for play-area soil lead levels.

Figures 11 through 13 show scatterplots of soil and dust lead levels with blood lead levels. The environmental data are presented in log form so that the distribution can be better visualized.

DISCUSSION

The primary purpose of this study was to evaluate the change in children's blood lead levels between 1991 and 2000 in the same geographical area of the Jasper County Superfund Site in Jasper County, Missouri to determine the effectiveness of environmental and educational interventions. A secondary objective was to evaluate blood lead levels of children living in homes that had undergone subsequent soil remediation. There was a 40% decline in average blood lead levels between the 1991 study and the 2000 study. These differences remained after adjusting for differences in demographic and behavioral factors between the two studies. In the 1991 study, 14% of the children tested had blood lead levels greater than or equal to 10 μg/dl. Nine years

later the proportion of children living in the same area as the 1991 study with elevated blood lead levels declined to 2%.

The geometric mean blood lead level for children 1–5 years of age in phase 2 (1991-1994) of NHANES III was 2.7 μg/dl. Blood lead levels declined to 2.0 μg/dl in the NHANES 1999 survey. This was a 0.7 μg/dl decline over five to eight years. Although the data on blood lead levels of children in NHANES is not comparable to that of children living in a lead mining area, the NHANES data does provide an estimate of the national decline in blood lead levels. The decline in blood lead levels for Jasper County is substantially greater than the national decline, suggesting that soil remediation and community education measures taken during this period were probably responsible for the decline in blood lead levels.

Reasons for this decline in blood lead levels are multifaceted. The EPA has replaced soil in approximately 2,288 homes during the period from 1991 to the initiation of the 2000 study. The Jasper County Health Department has been active in community education. It has worked with local radio, television, and print media to increase awareness in the community of the hazards of lead exposure in children, and has provided information on how to reduce exposure through improved home cleaning, personal hygiene, and nutrition. The Citizens Task Force developed a site-specific coloring and storybook, a Girl Scout merit badge, and public school health education curriculum. In addition, five homes have been paint abated or stabilized using HUD funds, and 95 homes have been refurbished using community development block grant money. In addition, a number of new homes have been built since the 1991 study.

Although the environmental measures of dust, paint, and soil are not directly comparable between the 1991 and 2000 study for reasons discussed above, it is interesting to note that the average indoor lead paint lead levels are similar for the two time periods (Table 9 and Table 15), even though the number of new homes has increased over time. The soil sampling during the 1991 study was a composite of yard areas other than the dripline, which was not sampled. The soil lead levels from non-dripline samples in the 2000 study were less than half those found during the 1991 study. This was most likely the result of the extensive soil remediation by EPA.

Blood lead levels were correlated with a number of variables (Table 12). As expected, older children had lower blood lead levels than younger children. The older the home the higher the blood lead levels, probably because the age of the home is related to the presence of lead paint. In homes where the response indicated a more frequent cleaning of the bedroom, the blood lead levels were higher. Since pets might carry lead dust on their fur, the positive correlation with playing with a pet and higher blood lead levels is reasonable. It is also to be expected that the more time a child plays outside and the more they play in dirt the higher their blood lead levels will be. Contrary to reported literature, mothers with more schooling have children with higher blood lead levels. Most of the environmental measures are positively associated with higher blood lead levels. More lead dust in the home, higher soil lead levels, and higher concentrations of lead based paint are all associated with increased blood lead levels.

Figures 7 through 10 indicate that children who live in homes that do not have interior lead based paint and have low levels of lead in the soil have substantially lower blood lead levels than children living in homes with either lead based paint or elevated soil lead levels. In general, blood lead levels are the highest for children living in homes with both lead based paint and elevated soil lead levels. Figure 10 shows a stepwise decline in average blood lead levels. The highest is for homes with lead paint and play area soil with levels greater than 250 ppm. The next highest is for homes with lead paint but soil lead levels less than 250 ppm, followed by homes with no lead paint but soil lead levels greater than 250 ppm. The lowest average blood lead levels are for children living in homes with no lead paint and play area soil levels less than 250 ppm. These differences, however, were not statistically significant.

A secondary objective of this study was to evaluate whether recontamination occurred in the soil remediated yards. There is not sufficient information available from the study to address this objective. To address this objective, yards that were sampled in the 2000 study should be resampled later to determine if soil lead levels have increased.

STUDY STRENGTHS

This study provided an opportunity to evaluate a soil remediation and health education effort to reduce childhood lead poisoning at the Jasper County Superfund Site nine years after the 1991 study. The census completion and percentage of those agreeing to participate was similar for both studies. An extensive environmental assessment of every home in the study provided data on paint and dust lead concentrations. These data were used to control for the effects of paint on blood lead levels. One of the indirect benefits of this study was that it expanded the resources available to continue health education efforts to reduce exposure to lead.

STUDY LIMITATIONS

Direct comparisons of the environmental data between the 1991 and 2000 study cannot be made because these data were collected by different methods. Because both health education, lead paint stabilizations, and soil remediation occurred over the same time period, it is not possible to determine the proportional reduction in childhood blood lead levels resulting from each of the intervention programs. In 32 homes during the 1991 study, two children per home were sampled and in one home three children were sampled, while in the 2000 study only one child per home was sampled. If we randomly select one child from each of the 33 homes in the 1991 study that had more than one child per home, the mean blood lead value changes only slightly from 6.24 μg/dl to 5.85 ± 3.96 μg/dl. The percent of children with blood lead levels greater than or equal to 10 μg/dl changed from 14% to 12% when only one child per home was selected.

CONCLUSIONS

Environmental and educational interventions initiated since 1991 to reduce blood lead levels of children living in a mining waste area of Jasper County, Missouri have been effective. Only two percent of the children tested that were living in the same area as selected for the 1991 study had blood lead levels greater than or equal to 10 μg/dl. This is an 86% reduction in the number of children suffering from lead poisoning. Although it is not possible to determine the individual contribution of the soil remediation compared to the health education and paint stabilization, it is reasonable to conclude that the substantial soil remediation actions contributed significantly to the reduction in numbers of children with elevated blood lead levels. Since those children with the higher mean lead levels were those with multi-media exposure, it is important to combine lead paint remedial actions with soil remediation.

RECOMMENDATIONS

In order to reduce blood lead levels of children living in communities with both lead contaminated soil and homes with lead based paint, a multimedia approach that addresses both lead contaminated soil and outdoor and indoor lead paint is needed. Future soil remediation actions should reduce recontamination of dripline soil resulting from exterior lead based paint.

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Table 1: Laboratory Methods, Detection, and Quantification Limits For Environmental Samples, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

Media and Analyte	Practical Quantification Limit [1,2]	Method Detection Limit [1,2]	Analysis Method
Dust Wipes	12.0 µg	3.8 µg	Digestion based on EPA SW-846 Method 3050 for acid digestion of sediments, sludge's and soils. Lead analysis based on SW-846 Method 7420 for flame atomic absorption spectrophotometry.
Soil	12.0 mg/kg	3.8 mg/kg	

[1] Dust wipe based on a nominal surface wipe area of 1 ft^2.
[2] Soil based on a nominal sample weight of 2.0 grams.

Table 2: Laboratory Quality Control Procedures, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

QC Procedure	Frequency	Criteria
Initial Calibration	Once per analysis run	None
High Standard Verification	Immediately after initial calibration	95 to 105% of actual concentration
Initial Calibration Verification	Immediately after high standard verification	90 to 110% of actual concentration
Continuing Calibration Verification	Every 10 samples and at the end of the run	90 to 110% of actual concentration
Continuing Blank Verification	Every 10 samples and at the end of the run	Less than detection limit
Interference Check Standard	Beginning and end run plus every 8 hours	80 to 120% of actual concentration
High Sample Results	For every analyte over high standard response	Dilute the sample within the calibration range

Table 3: Quality Control Summary Results For Standard Reference Material and Duplicate Soil Samples, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

Media	Units[1]	Number of Samples	Frequency [2] Achieved (%)	RPD [3,4] Minimum	RPD [3,4] Maximum	RPD [3,4] Mean	RPD [3,4] SD [6]	95% Confidence[7] LCL	95% Confidence[7] UCL
Soil SRM	mg/kg	15	1.8	3.0	54.0	21.5	18.6	11.1	31.8
Dust Wipe SRM	µg	48	5.4	0	77.0	13.6	14.7	9.4	17.9
Soil Duplicates	mg/kg	20	2.5	41.0	148.5	37.3 [5]	45.6	15.9	58.7

[1] µg = micrograms, mg = milligram, kg = kilograms.
[2] Intended frequency for soil and dust wipe SRM's 2%.
[3] Relative Percent Difference for SRM's [(|SRM value – Lab value|)/SRM value*100.
[4] Relative Percent Difference for Duplicate Soils [|Samp1 – Samp2|/(Samp1 + Samp2)*100].
[5] Soil duplicate RPD medium value 16.3.
[6] SD = standard deviation.
[7] LCL = Lower Confidence Limit, UCL = Upper Confidence Limit.

Table 4: Quality Control Summary Results For Field Blanks, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

Field blank Type	Number of Samples	Frequency Achieved (%)[1]	Greater Than PQL[2]	Between PQL[2] – MDL[3]	Below MDL
Dust wipes	63	7.1	0	0	63 (100%)
Glove Wipes	15	1.7	2 (13%)	3 (20%)	10 (67%)
Total Field Blanks	78	8.8	2 (2.6)	3 (3.8%)	73 (93.6%)

[1] Intended frequency was 5%.
[2] PQL = Practical Quantification Limit
[3] MDL = Method Detection Limit

Table 5: Number of residences determined from the census visits by student workers and the percent of each response, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

Category	Number of Responses	Percent of Total
Business	896	9.9%
Refused to Participate	55	.6%
No Eligible Children	5078	55.9%
Vacant Home	750	8.3%
Unable to Contact	745	8.2%
Eligible Participant	957	10.5%
No Structure at Listed Address	604	6.6%
Total	**9085**	

Total Number of Homes in Area[1]	6835
Percent Response[2]	89.1%

1. Total Number of Homes = Eligible participants + No eligible children + Unable to contact + Refused to participate
2. Percent Response = (Eligible participants + No eligible children + Refused to participate)/ (Total number of homes)

Table 6: Results of multiple attempts to contact potential participants* for the data collection , Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

Contact	Participant	Moved	Refused
1	63	53	78
2	67	38	59
3	48	32	43
4	33	13	34
5	11	8	29
6	17	10	17
7	10	5	20
8	5	6	13
9 or more	4	16	58
Unknown[1]	29	1	0
Total	287	182	351

1. Unknown represents those that had information on the potential participant but no recruiting sheet recording the number of attempts made to contact the individual.*46 eligible participants were excluded from the study due to inability to contact them.

Table 7: Results of contacts of potential study participants in the two study areas during the data collection, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

Result	1991 Study Area	Oversample Area	Total for Study
Participated	215	72	287
Moved	75	107	182
Refused	247	123	370
No Contact Made	38	8	46
Excluded[1]	50	21	71
Duplicate	1	0	1
Total	626	331	957

1. Excluded were those potential participants not drawn for the random sample.

Table 8: Reasons documented from potential participants that did not wish to participate, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

Reason Refused	Number of Responses	Percent Response
Refused to respond	104	29.6
Didn't want blood tested	84	23.9
Child's blood already tested[1]	69	19.7
No time to take part	35	10.0
Moving from home soon	23	6.6
Lack of concern	16	4.6
Medical reasons	6	1.7
Didn't want samples taken	4	1.1
Dissatisfied with EPA work	2	.6
Other response	8	2.3
Total	351	

1. Forty-four of the 69 potential participants that responded with this reason did have a blood test on record in the state system. Three of those 44 had an elevated child in the residence.

Table 9: Mean and Standard Deviation Environmental and Blood Lead Results, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

	2000 Study Area		2000 Study Area & Oversample Area	
Factor	**N**	**Mean ± SD**	**N**	**Mean ± SD**
Blood Lead Level µg/dl	213	3.8 ± 2.3	284	4.1 ± 2.6
Window sill composite loading µg/ft^2	188	403.0 ± 2459	260	371 ± 2121.1
Miniblind composite loading µg/ft^2	170	1534.6 ± 3696	229	1305.4 ± 3275.2
Floor composite loading µg/ft^2	214	3.8 ± 8.2	286	4.0 ± 10.1
Mean lead dust loading µg/ft^2	214	361.8 ± 998	286	343.8 ± 896.7
Dripline soil mg/kg	215	841.9 ± 2652	287	1169 ± 3289.1
Play area soil mg/kg	154	233.8 ± 269	202	260.9 ± 299.1
Yard soil mg/kg	215	292.3 ± 514	287	293.8 ± 459
Overall soil mg/kg	215	518.8 ± 1382	287	629.6 ± 1452
Outdoor wall total XRF mg/cm^2	186	1.6 ± 3.2	252	2.1 ± 3.7
Porch total XRF mg/cm^2	144	3.0 ± 5.9	205	3.6 ± 6.4
Outside structure total XRF mg/cm^2	194	1.8 ± 3.4	262	2.4 ± 3.8
Mean window stool XRF mg/cm^2	161	0.8 ± 2.2	226	0.79 ± 2.1
Mean miniblind XRF mg/cm^2	162	3.9 ± 3.5	220	3.5 ± 3.5
Mean indoor total XRF mg/cm^2	211	1.1 ± 1.6	281	1.1 ± 1.6

Table 10: Questionnaire Responses by Factors for the 2000 Study, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	RESPONSE N (%)
Person answering question	
Mother	243 (84.7)
Father	31 (10.8)
Grandparent	7 (2.4)
Other person	6 (2.1)
Gender	
Male	149 (52.1)
Female	137 (47.9)
Race	
American Indian/ Alaskan Native	13 (4.6)
Asian/ Pacific Islander	1 (0.4)
Black	4 (1.4)
White	257 (90.2)
Other	9 (3.2)
Don't know	1 (0.4)
Is child Hispanic or of Spanish Descent	
Yes	29 (10.1)
No	255 (89.2)
Don't Know	2 (0.7)
Total gross household income before taxes:	
$\leq$ $4,999	16 (5.6)
$5,000-$9,999	20 (7.0)
$10,000-$14,999	30 (10.5)
$15,000-$19,999	31 (10.9)
$20,000-$24,999	30 (10.5)
$25,000-$29,999	26 (9.1)
$30,000-$34,999	31 (10.9)
$35,000-$39,999	25 (8.8)
$\geq$ $40,000	65 (22.8)
Refused	1 (0.4)
Don't Know	10 (3.5)
Highest year of education completed by the head of the household:	
No schooling	2 (0.7)
Elementary School	19 (6.6)
High School	142 (49.7)
Technical or Trade School	29 (10.1)
Junior/Community College	38 (13.3)
Four year College/University	45 (15.7)
Attended Graduate school	10 (3.5)
Refused	1 (0.3)
Is the mother the head of the household?	
Yes	84 (29.5)
No	201 (70.5)

Table 10: (cont.) Questionnaire Responses by Factors for the 2000 Study, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	RESPONSE N (%)
Highest year of education completed by the mother of the child:	
No schooling	2 (0.9)
Elementary School	20 (9.3)
High School	102 (47.7)
Technical or Trade School	16 (7.5)
Junior/Community College	26 (12.1)
Four year College/University	39 (18.2)
Attended Graduate school	4 (1.9)
Don't know	4 (1.9)
Year house was built	
<1900-1909	24 (8.4)
1910-1919	6 (2.1)
1920-1929	12 (4.2)
1930-1939	14 (4.9)
1940-1949	20 (7.0)
1950-1959	20 (7.0)
1960-1969	14 (4.9)
1970-1979	25 (8.7)
1980-1989	24 (8.4)
1990-present	61 (21.3)
Refused	1 (0.3)
Don't know	66 (23.0)
House rented or owned?	
Rented	107 (37.3)
Owned	172 (59.9)
Other	8 (2.8)
How many people in the home are less than 7 years of age?	
1	161 (56.1)
2	88 (30.7)
3	36 (12.5)
How many people in the home are 7 to 12 years of age?	
0	173 (60.5)
1	82 (28.7)
2	25 (8.7)
3	5 (1.7)
4	1 (0.3)
How many people in the home are 13 to 18 years of age?	
0	242 (84.3)
1	32 (11.1)
2	12 (4.2)
3	1 (0.3)

Table 10: (cont.) Questionnaire Responses by Factors for the 2000 Study, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	RESPONSE N (%)
How long has the child been living in this home? (months)	25.5 ± 19.4 (287)
Type of water pipes	
Lead	4 (1.4)
Plastic	139 (48.8)
Galvanized Steel	26 (9.1)
Copper	10 (3.5)
Iron	1 (0.3)
Mixed	29 (10.2)
Other	4 (1.4)
Don't Know	72 (25.3)
Source of house water for drinking	
Public water	244 (85.0)
Well	5 (1.7)
Bottled	28 (9.8)
Cistern	
Local Spring or Brook	
Mixed	10 (3.5)
Other	
Source of house water for cooking	
Public water	271 (94.4)
Well	5 (1.7)
Bottled	6 (2.1)
Cistern	
Local Spring or Brook	1 (0.3)
Mixed	
Other	4 (1.4)
What type of exterior does your home have?	
Wood	112 (39.0)
Brick	19 (6.6)
Block	3 (1.0)
Mobile home	29 (10.1)
Vinyl/Metal siding	94 (32.8)
Other	26 (9.1)
Refused	
Don't know	4 (1.4)
Any part of house repainted, sanded, or stripped chemically or by heat within last year?	
Yes	113 (39.5)
No	170 (59.4)
Don't know	3 (1.0)

Table 10: (cont.) Questionnaire Responses by Factors for the 2000 Study, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	RESPONSE N (%)
Is home air conditioned	
Yes	260 (90.9)
No	26 (9.1)
Does home have central air or window unit	
Central air	140 (51.7)
Window Unit	125 (46.1)
Both	5 (1.8)
Mine, smelter, or lead industry materials used in or around house or yard	
Yes	42 (14.7)
No	229 (80.4)
Don't know	14 (4.9)
Pets go in and out of house	
Yes	107 (37.9)
No	175 (62.1)
How often does your child play with your pet?	
Never	3 (2.7)
Less than once per week	6 (5.4)
Once per week	6 (5.4)
Less than once per day, but more than once per week	10 (8.9)
Once per day	20 (17.9)
More than once per day	67 (59.8)
How often are the child's hands washed after playing with the pet?	
Never	18 (17.0)
Less than once per week	3 (2.8)
Once per week	2 (1.9)
Less than once per day, but more than once per week	9 (8.5)
Once per day	18 (17.0)
More than once per day	56 (52.8)
In the last 90 days, any member of household:	
Painted pictures with artists' paints?	
Yes	20 (7.0)
No	264 (93.0)
Painted, stained, or refinished furniture?	
Yes	28 (9.8)
No	257 (90.2)
Painted the inside or outside of a home or building?	
Home	40 (87.0)
Work	5 (10.9)
Both	1 (2.2)
Worked with stained glass?	
Yes	
No	284 (100.0)
Cast lead into fishing sinkers, bullets or anything else?	
Yes	8 (2.8)
No	277 (97.2)
Refused	1 (0.4)

Table 10: (cont.) Questionnaire Responses by Factors for the 2000 Study, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	RESPONSE N (%)
In the last 90 days, any member of household:	
Worked with soldering in electronics?	
Yes	24 (8.4)
No	261 (91.6)
Worked with soldering pipes or sheets of metal?	
Yes	8 (2.8)
No	277 (97.2)
Repaired auto radiators?	
Yes	6 (2.1)
No	279 (97.9)
Worked on auto bodies or auto maintenance? (includes mechanics)	
Yes	63 (22.0)
No	224 (78.0)
Worked at a sewage treatment plant?	
Yes	2 (0.7)
No	282 (99.3)
Made pottery?	
Yes	3 (1.1)
No	280 (98.9)
Ridden a dirt bike, mountain bike, or ATV in the local area?	
Yes	30 (10.5)
No	256 (89.5)
Welded?	
Yes	20 (7.0)
No	265 (93.0)
Cleaned or repaired firearms?	
Yes	20 (7.0)
No	265 (93.0)
Visited indoor firearm target ranges?	
Yes	2 (0.7)
No	282 (98.9)
Don’t know	1 (0.4)
Done wire/cable cutting or splicing?	
Yes	53 (18.5)
No	234 (81.5)
Casted or smelted lead?	
Yes	3 (1.0)
No	283 (99.0)
Worked in plastics manufacture?	
Yes	3 (1.1)
No	282 (98.9)
Worked in battery manufacture?	
Yes	5 (1.8)
No	280 (98.2)
Worked in pipe machining?	
Yes	4 (1.4)
No	282 (98.6)
Done electroplating with lead solutions?	
Yes	
No	285 (100.0)
Worked in refining gasoline?	
Yes	
No	285 (100.0)

Table 10: (cont.) Questionnaire Responses by Factors for the 2000 Study, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	RESPONSE N (%)
In the last 90 days, any member of household:	
Worked in paint, glaze, and ink manufacture?	
Yes	
No	285 (100.0)
Worked in rubber manufacture?	
Yes	2 (0.7)
No	283 (99.3)
Worked in scrap metal recovery?	
Yes	12 (4.2)
No	274 (95.8)
Had any other lead-related job of activity?	
Yes	3 (1.1)
No	282 (98.9)
People living in house worked in mining or a mining-related job in last 90 days?	
Yes	3 (1.0)
No	282 (98.6)
Refused	1 (0.3)
When food or drinks are prepared, served or stored, are they often placed in clay pottery or ceramic dishes which were homemade or made in another country?	
Yes	13 (4.6)
No	271 (95.1)
Don't know	1 (0.4)
When food or drinks are prepared, served, or stored are they often placed in copper or pewter dishes or containers?	
Yes	1 (0.3)
No	285 (99.7)
When food or drinks are stored or put away, are they sometimes stored in the original container after being opened?	
Yes	37 (13.1)
No	246 (86.9)
How often do you vacuum?	
Never	12 (4.2)
Rarely	
Sometimes	26 (9.1)
Frequently	151 (52.6)
Always	98 (34.1)
How often do you dry sweep?	
Never	21 (7.3)
Rarely	16 (5.6)
Sometimes	32 (11.1)
Frequently	121 (42.2)
Always	97 (33.8)

Table 10: (cont.) Questionnaire Responses by Factors for the 2000 Study, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	RESPONSE N (%)
How often do you mop?	
Never	20 (7.0)
Rarely	19 (6.6)
Sometimes	105 (36.6)
Frequently	120 (41.8)
Always	23 (8.0)
How often do you wet wipe?	
Never	8 (2.8)
Rarely	22 (7.7)
Sometimes	63 (22.0)
Frequently	116 (40.4)
Always	78 (27.2)
How often do you dry dust?	
Never	64 (22.3)
Rarely	62 (21.6)
Sometimes	102 (35.5)
Frequently	39 (13.6)
Always	20 (7.0)
How often do you use other house cleaning methods?	
Never	73 (25.4)
Rarely	101(35.2)
Sometimes	77 (26.8)
Frequently	29 (10.1)
Always	7 (2.4)
How long do you spend cleaning the following rooms each time you clean them? (minutes)	
Kitchen	31.1 ± 32.4 (287)
Child's bedroom	30.6 ± 37.8 (287)
Living/family room	25.6 ± 32.4 (286)
Do you have a vacuum cleaner?	
Yes	272 (94.8)
No	15 (5.2)
How many total hours does your child spend at home Monday through Friday?	105.4 ± 20.4 (287)
How many total hours does your child spend at home Saturday and Sunday?	45.7 ± 6.8 (287)
How many total hours does your child spend at the babysitter (outside of home) Monday through Friday?	4.0 ± 11.8 (287)

Table 10: (cont.) Questionnaire Responses by Factors for the 2000 Study, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	RESPONSE N (%)
How many total hours does your child spend at the babysitter (outside of home) Saturday and Sunday?	0.1 ± 1.3 (287)
How many total hours does your child spend at the daycare (commercial facility) Monday through Friday?	5.0 ± 12.7 (287)
How many total hours does your child spend at the daycare (commercial facility) Saturday and Sunday?	0.3 ± 2.1 (287)
How many total hours does your child spend at the other locations Monday through Friday?	5.3 ± 13.3 (287)
How many total hours does your child spend at the other locations Saturday and Sunday?	1.6 ± 5.6 (287)
On the average, how many hours per day does the child Play outside during the spring and fall?	3.4 ± 6.1 (286)
On the average, how many hours per day does the child Play outside during the winter?	0.87 ± 1.5 (286)
On the average, how many hours per day does the child Play outside during the summer?	3.3 ± 2.7 (286)
Does anyone smoke cigarettes in the child's house?	
Yes	136 (47.6)
No	150 (52.4)
If yes, how many cigarettes per day in the child's house?	23.8 ± 16.5 (133)
Does anyone smoke cigars in the child's house?	
Yes	7 (2.5)
No	270 (97.5)
Does anyone smoke pipes in the child's house?	
Yes	6 (2.2)
No	271 (97.8)
How long has the child lived in this home? (months)	25.5 ± 19.4 (287)
Have you ever used smokeless tobacco products?	
Yes	41 (14.3)
No	245 (85.7)
How many people smoke in this house?	1.6 ± 2.9 (283)
Does child breast feed? (Only for participants ≤3yrs old)	
Yes	4 (2.9)
No	132 (97.1)
Does child currently take a bottle?	
Yes	34 (24.6)
No	104 (75.4)

Table 10: (cont.) Questionnaire Responses by Factors for the 2000 Study, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	RESPONSE N (%)
Hours per day the child usually spends playing on the floor in this house:	5.9 ± 3.8 (286)
Does the child play outdoors, around the house, or in the neighborhood?	
Yes	250 (87.7)
No	35 (12.3)
If the child plays outdoors then how many hours a day on the average does the child play outdoors?	3.0 ± 2.2 (257)
Where does child usually play outdoors around the house?	
Back yard	120 (46.5)
Front yard	96 (37.2)
Side yard	31 (12.0)
Other	11 (4.3)
Where does the child usually play (in last 90 days) when not at home?	
Neighbor's yard	48 (18.6)
Playground	11 (4.3)
Near or around creek or ditch	2 (0.8)
On or near sidewalks or streets	9 (3.5)
Park	22 (8.5)
Only plays around the home	92 (35.7)
Other	73 (28.3)
Don't know	1 (0.4)
Is the ground where the child usually plays mainly:	
Grassy	186 (72.4)
Concrete/asphalt	16 (6.2)
Dirt/Soil	39 (15.2)
Sandbox	2 (0.8)
Other	14 (5.4)
How often does the child play in grassy area?	
None of the time	8 (3.1)
Less than half the time	31 (12.1)
Half the time	85 (33.1)
More than half the time	94 (36.6)
All the time	39 (15.2)
How often does the child play on concrete/asphalt?	
None of the time	49 (18.9)
Less than half the time	128 (49.4)
Half the time	55 (21.2)
More than half the time	19 (7.3)
All the time	8 (3.1)

Table 10: (cont.) Questionnaire Responses by Factors for the 2000 Study, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	RESPONSE N (%)
How often does the child play in dirt?	
None of the time	50 (19.3)
Less than half the time	115 (44.4)
Half the time	46 (17.8)
More than half the time	26 (10.0)
All the time	22 (8.5)
How often does the child play on mine waste materials?	
None of the time	222 (86.4)
Less than half the time	23 (8.9)
Half the time	4 (1.6)
More than half the time	6 (2.3)
All the time	2 (0.8)
Does child :	
Crawl	4 (2.9)
Walk	98 (71.0)
Both	31 (22.5)
Neither	5 (3.6)
How often does child eat food that has fallen on floor?	
Never	129 (45.4)
Less than once per week	57 (20.1)
Once per week	23 (8.1)
Less than once per day, but more than once per week	30 (10.6)
Once per day	17 (6.0)
More than once per day	28 (9.9)
Where does your child usually eat?	
Sitting at the table	171 (59.8)
Sitting on the floor	27 (9.4)
Sitting in a high chair	62 (21.7)
Other	26 (9.1)
Does the child often take food, snacks, candy, bottle, or pacifier with him or her outside to play?	
Yes	145 (51.4)
No	137 (48.6)
How often does child eat food, snacks, or candy outside during the spring, summer and fall?	
Never	11 (7.0)
Less than once per month	38 (24.1)
Once per month	30 (19.0)
Less than once per week, but more than once per month	36 (22.8)
Once per week	30 (19.0)
Less than once per day, but more than once per week	13 (8.2)
How often does child take bottle/pacifier out with them?	
Never	18 (46.2)
Rarely	11 (28.2)
Sometimes	2 (5.1)
Frequently	3 (7.7)
Always	5 (12.8)

Table 10: (cont.) Questionnaire Responses by Factors for the 2000 Study, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	RESPONSE N (%)
How often is the child's pacifier washed?	
Never	
Less than once per month	3 (7.7)
Once per month	1 (2.6)
Less than once a week, but more than once a month	2 (5.1)
Once per week	1 (2.6)
Less than once a day, but more than once a week	6 (15.4)
Everyday	25 (64.1)
Child does not have a pacifier	1 (2.6)
How often does the child use a cup with lid (sipee cup), bottle or pacifier outside during the spring, summer, and fall?	
Never	108 (37.9)
Less than once per week	37 (13.0)
Once per week	19 (6.7)
Less than once per day, but more than once per week	38 (13.3)
Once per day	40 (14.0)
More than once per day	43 (15.1)
Are the child's hands or face usually washed before eating?	
Yes	266 (93.3)
No	19 (6.7)
How often does the child wash hands or face before eating?	
Never	3 (1.1)
Less than once per week	3 (1.1)
Once per week	2 (0.7)
Less than once per day, but more than once per week	7 (2.6)
Once per day	27 (9.9)
More than once per day	230 (84.6)
Are the child's hands or face usually washed before going to sleep?	
Yes	270 (94.7)
No	15 (5.3)
How often does the child wash hands or face before going to sleep?	
Never	
Less than once per week	11 (4.0)
Once per week	
Less than once per day, but more than once per week	13 (4.7)
Once per day	106 (38.7)
More than once per day	144 (52.6)
Are the child's hands or face usually washed after playing with dirt or sand?	
Yes	260 (92.9)
No	20 (7.1)

Table 10: (cont.) Questionnaire Responses by Factors for the 2000 Study, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	RESPONSE N (%)
How often does the child wash hands or face after playing with dirt or sand?	
Never	4 (1.5)
Less than once per week	12 (4.5)
Once per week	4 (1.5)
Less than once per day, but more than once per week	4 (1.5)
Once per day	31 (11.7)
More than once per day	209 (78.9)
Don't know	1 (0.4)
Number of times the child is bathed or given a shower per week:	6.7 ± 6.1 (286)
Has the child used a pacifier in the last 6 months?	
Yes	36 (13.3)
No	234 (86.7)
Does the child suck his/her thumb or fingers	
Yes	70 (24.5)
No	216 (75.5)
Does the child chew on their fingernails?	
Yes	73 (25.7)
No	210 (73.9)
Don't know	1 (0.4)
Does the child have a favorite blanket or toy?	
Yes	150 (52.6)
No	135 (47.4)
For those answering yes, does the child carry this around during the day?	
Yes	83 (51.6)
No	78 (48.4)
For those answering yes, does the child put this blanket or toy in their mouth?	
Yes	62 (38.5)
No	99 (61.5)
How often are toys and stuffed animals washed?	
Never	57 (20.1)
Less than once per month	92 (32.5)
Once per month	67 (23.7)
Less than once a week, but more than once a month	29 (10.2)
Once per week	25 (8.8)
Less than once a day, but more than once a week	8 (2.8)
Everyday	5 (1.8)

Table 10: (cont.) Questionnaire Responses by Factors for the 2000 Study, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	RESPONSE N (%)
How often does the child put things other than food into their mouth ?	
Does this a lot	53 (18.5)
Just once in a while	113 (39.4)
Almost never	50 (17.4)
Never	68 (23.7)
Does the child put their mouth on furniture or on the window sill?	
Does this a lot	20 (7.0)
Just once in a while	67 (23.5)
Almost never	48 (16.8)
Never	150 (52.6)
Does the child swallow things other than food?	
Does this alot	2 (0.7)
Just once in a while	17 (6.0)
Almost never	47 (16.5)
Never	219 (76.8)
Does the child put paint chips in their mouth?	
Does this alot	
Just once in a while	1 (0.4)
Almost never	7 (2.5)
Never	275 (96.5)
Don't know	2 (0.7)
Does your household have a vegetable garden?	
Yes	37 (13.1)
No	245 (86.9)
For those answering yes, how often does the child eat vegetables grown in your garden?	
Once per week or more	13 (33.3)
Less than once per week	7 (17.9)
Never	18 (46.2)
Refused	1 (2.6)
How often does your child eat root vegetables (such as beets or turnips) grown in your garden?	
Once per week or more	3 (12.0)
Less than once per week	1 (4.0)
Never	21 (84.0)
How often does your child eat leafy green vegetables (such as lettuce or spinach) grown in your garden?	
Once per week or more	2 (8.3)
Less than once per week	4 (16.7)
Never	18 (75.0)
Has soil been hauled in and placed on your garden?	
Yes	11 (42.3)
No	12 (46.2)
Don't know	1 (3.8)

Table 10: (cont.) Questionnaire Responses by Factors for the 2000 Study, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	RESPONSE N (%)
How often does the child eat vegetables grown elsewhere in the local area?	
Once per week or more	34 (12.1)
Less than once per week	65 (23.2)
Never	181 (64.6)
How often does your child eat root vegetables (such as beets or turnips) grown elsewhere in the area?	
Once per week or more	14 (11.5)
Less than once per week	24 (19.7)
Never	84 (68.9)
How often does your child eat leafy green vegetables (such as lettuce or spinach) grown elsewhere in the area?	
Once per week or more	18 (14.9)
Less than once per week	27 (22.3)
Never	76 (62.8)
Has the child ever been treated with traditional, folk, or herbal medications?	
Yes	21 (7.4)
No	264 (92.6)
Number of people living in house:	4.3 ± 1.4 (287)
Amount of out-of-pocket money spent each week on meat, vegetables and milk products in this household:	
≤ $25	34 (11.9)
$26-$50	95 (33.3)
$51-$75	73 (25.6)
$76-$100	44 (15.4)
> $100	38 (13.3)
Refused	1 (0.4)
Amount of out-of-pocket money spent each week on items other than meat, vegetables and milk products in this household:	
≤ $25	69 (24.1)
$26-$50	114 (39.9)
$51-$75	59 (20.6)
$76-$100	25 (8.7)
> $100	17 (5.9)
Refused	1 (0.3)
Don't know	1 (0.3)
Do you receive food stamps, WIC vouchers, food from pantries, or any other programs?	
Yes	115 (40.2)
No	171 (59.8)

Table 11: Average Blood Lead Levels by Questionnaire Response, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	MEAN (μg/dl) ± S.D. (N)
Person answering question	
Mother	4.0 ± 2.3 (241)
Father	4.7 ± 3.3 (30)
Grandparent	6.9 ± 4.3 (7)
Other person	2.8 ± 1.1 (6)
Gender	
Male	4.2 ± 2.5 (147)
Female	4.0 ± 2.6 (136)
Race	
American Indian/ Alaskan Native	4.6 ± 2.1 (12)
Asian/ Pacific Islander	4.8 ± - (1)
Black	3.0 ± 3.3 (4)
White	4.1 ± 2.6 (255)
Other	4.4 ± 2.8 (9)
Don't know	3.2 ± - (1)
Is child Hispanic or of Spanish Descent	
Yes	4.0 ± 2.8 (29)
No	4.1 ± 2.5 (252)
Don't Know	3.9 ± 0.7 (2)
Total gross household income before taxes:	
≤ $4,999	6.3 ± 3.5 (15)
$5,000-$9,999	4.4 ± 3.0 (20)
$10,000-$14,999	4.3 ± 1.8 (30)
$15,000-$19,999	5.4 ± 4.0 (31)
$20,000-$24,999	4.2 ± 2.1 (30)
$25,000-$29,999	4.5 ± 2.4 (25)
$30,000-$34,999	3.1 ± 1.0 (31)
$35,000-$39,999	3.3 ± 1.7 (25)
≥ $40,000	3.5 ± 2.2 (64)
Refused	3.3 ± - (1)
Don't Know	2.7 ± 0.8 (10)
Highest year of education completed by the head of the household:	
No schooling	4.2 ± 0.9 (2)
Elementary School	5.4 ± 2.3 (18)
High School	4.3 ± 2.7 (141)
Technical or Trade School	4.3 ± 2.4 (29)
Junior/Community College	3.2 ± 1.9 (37)
Four year College/University	3.7 ± 2.4 (45)
Attended Graduate school	4.0 ± 3.9 (10)
Refused	3.5 ± - (1)
Is the mother the head of the household?	
Yes	4.2 ± 2.5 (84)
No	4.0 ± 2.6 (198)

Table 11: (cont.) Average Blood Lead Levels by Questionnaire Response, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	MEAN (µg/dl) ± S.D. (N)
Highest year of education completed by the mother of the child:	
No schooling	6.0 ± 2.0 (2)
Elementary School	4.6 ± 2.1 (20)
High School	4.1 ± 2.6 (101)
Technical or Trade School	3.9 ± 1.7 (16)
Junior/Community College	4.2 ± 2.8 (24)
Four year College/University	3.0 ± 1.9 (39)
Attended Graduate school	3.4 ± 0.9 (4)
Don't know	6.7 ± 5.7 (4)
Year house was built[5]	
<1900-1909	4.5 ± 2.0 (23)
1910-1919	3.6 ± 2.6 (6)
1920-1929	4.5 ± 3.6 (12)
1930-1939	3.4 ± 1.4 (14)
1940-1949	5.1 ± 2.5 (20)
1950-1959	4.6 ± 3.0 (20)
1960-1969	5.0 ± 3.1 (14)
1970-1979	4.3 ± 2.6 (25)
1980-1989	2.9 ± 1.8 (24)
1990-present	3.1 ± 1.5 (61)
Refused	3.3 ± - (1)
Don't know	4.7 ± 3.1 (64)
House rented or owned?	
Rented	4.8 ± 2.9 (106)
Owned	3.6 ± 2.2 (170)
Other	5.5 ± 2.8 (8)

Table 11: (cont.) Average Blood Lead Levels by Questionnaire Response, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	MEAN (µg/dl) ± S.D. (N)
Type of water pipes	
Lead	7.1 ± 5.8 (4)
Plastic	3.8 ± 2.3 (138)
Galvanized Steel	4.5 ± 2.9 (26)
Copper	3.5 ± 1.3 (10)
Iron	1.0 ± - (1)
Mixed	4.6 ± 2.2 (28)
Other	3.9 ± 2.1 (4)
Don't Know	4.3 ± 2.9 (71)
Source of house water for drinking	
Public water	4.2 ± 2.6 (241)
Well	4.1 ± 3.1 (5)
Bottled	3.3 ± 1.5 (28)
Cistern	
Local Spring or Brook	
Mixed	3.3 ± 1.8 (10)
Other	
Source of house water for cooking	
Public water	4.1 ± 2.5 (268)
Well	4.3 ± 3.1 (5)
Bottled	3.6 ± 1.2 (6)
Cistern	
Local Spring or Brook	15.8 ± - (1)
Mixed	
Other	3.0 ± 1.2 (4)
What type of exterior does your home have?	
Wood	4.5 ± 3.0 (111)
Brick	3.9 ± 2.3 (19)
Block	2.9 ± 1.0 (3)
Mobile home	3.7 ± 1.7 (29)
Vinyl/Metal siding	3.8 ± 2.1 (93)
Other	4.4 ± 2.8 (25)
Refused	
Don't know	5.1 ± 2.3 (4)
Any part of house repainted, sanded, or stripped chemically or by heat within last year?	
Yes	4.3 ± 2.9 (113)
No	4.0 ± 2.3 (167)
Don't know	4.8 ± 3.9 (3)

Table 11: (cont.) Average Blood Lead Levels by Questionnaire Response, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	MEAN (µg/dl) ± S.D. (N)
Is home air conditioned	
Yes	4.0 ± 2.5 (257)
No	5.0 ± 3.2 (26)
Does home have central air or window unit	
Central air	3.5 ± 2.2 (138)
Window Unit	4.5 ± 2.6 (124)
Both	5.2 ± 1.9 (5)
Reefused	3.5 ± - (1)
Mine, smelter, or lead industry materials used in or around house or yard	
Yes	4.4 ± 3.5 (41)
No	4.0 ± 2.3 (227)
Don't know	4.7 ± 2.5 (14)
Pets go in and out of house	
Yes	4.3 ± 2.6 (107)
No	3.9 ± 2.5 (172)
How often does your child play with your pet?	
Never	2.5 ± 1.4 (3)
Less than once per week	2.9 ± 0.7 (6)
Once per week	4.4 ± 2.3 (6)
Less than once per day, but more than once per week	4.1 ± 2.4 (9)
Once per day	3.6 ± 1.5 (20)
More than once per day	4.7 ± 2.9 (67)
How often are child's hands washed after playing with pet?	
Never	3.4 ± 1.9 (18)
Less than once per week	3.7 ± 0.2 (3)
Once per week	6.8 ± 2.0 (2)
Less than once per day, but more than once per week	3.6 ± 1.7 (9)
Once per day	4.5 ± 4.1 (18)
More than once per day	4.6 ± 2.3 (56)
In the last 90 days, any member of household:	
Painted pictures with artists' paints?	
Yes	4.5 ±2.9 (20)
No	4.1 ± 2.5 (261)
Painted, stained, or refinished furniture?	
Yes	3.6 ±2.1 (24)
No	3.2 ± 0.44 (3)
Worked with soldering in electronics?	
Yes	5.2 ± 4.1 (24)
No	4.0 ± 2.3 (258)
Worked on auto bodies or auto maintenance? (includes mechanics)	
Yes	4.6 ± 3.2 (62)
No	3.9 ± 2.3 (222)

Table 11: (cont.) Average Blood Lead Levels by Questionnaire Response, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	MEAN (µg/dl) ± S.D. (N)
Ridden a dirt bike, mountain bike, or ATV in the local area?	
Yes	4.2 ± 2.1 (30)
No	4.1 ± 2.6 (253)
Welded?	
Yes	5.2 ± 4.7 (19)
No	4.0 ± 2.3 (263)
Cleaned or repaired firearms?	
Yes	4.2 ± 3.2 (19)
No	4.1 ± 2.5 (263)
Done wire/cable cutting or splicing?	
Yes	4.3 ±3.0 (52)
No	4.0 ±2.5 (232)
Worked in scrap metal recovery?	
Yes	5.0 ±3.1 (12)
No	4.0 ± 2.5 (271)
People living in house worked in mining or a mining-related job in last 90 days?	
Yes	2.7 ± 0.7 (3)
No	4.1 ± 2.6 (280)
Refused	3.0 ± - (1)
When food or drinks are prepared, served or stored, are they often placed in clay pottery or ceramic dishes which were homemade or made in another country?	
Yes	5.6 ± 3.3 (12)
No	4.0 ± 2.5 (269)
Don't know	2.4 ± - (1)
When food or drinks are prepared, served, or stored are they often placed in copper or pewter dishes or containers?	
Yes	3.0 ± - (1)
No	4.1 ± 2.6 (282)
When food or drinks are stored or put away, are they sometimes stored in the original container after being opened?	
Yes	4.0 ± 2.3 (36)
No	4.1 ± 2.6 (244)
How often do you vacuum?	
Never	3.8 ± 1.0 (12)
Rarely	
Sometimes	3.9 ± 2.6 (25)
Frequently	3.9 ± 2.3 (151)
Always	4.5 ± 3.0 (96)

Table 11: (cont.) Average Blood Lead Levels by Questionnaire Response, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	MEAN (µg/dl) ± S.D. (N)
How often do you dry sweep?	
Never	4.2 ± 3.1 (21)
Rarely	4.8 ± 3.8 (19)
Sometimes	4.2 ± 2.9 (105)
Frequently	3.9 ± 2.0 (119)
Always	3.9 ± 2.4 (21)
How often do you wet wipe?	
Never	5.6 ± 5.3 (8)
Rarely	3.6 ± 1.9 (22)
Sometimes	4.3 ± 2.9 (62)
Frequently	4.3 ± 2.5 (114)
Always	3.5 ± 1.9 (78)
How often do you dry dust?	
Never	3.5 ± 1.8 (63)
Rarely	3.9 ± 2.0 (62)
Sometimes	4.8 ± 3.1 (100)
Frequently	3.8 ± 2.5 (39)
Always	3.8 ± 2.5 (20)
How often do you use other house cleaning methods?	
Never	4.0 ± 1.9 (71)
Rarely	4.1 ± 3.1 (101)
Sometimes	4.3 ± 2.4 (77)
Frequently	3.8 ± 2.4 (28)
Always	3.8 ± 1.6 (7)
)o you have a vacuum cleaner?	
Yes	4.1 ± 2.6 (269)
No	4.2 ± 1.8 (15)
Does anyone smoke cigarettes in the child's house?	
Yes	4.5 ± 2.7 (136)
No	3.7 ± 2.4 (147)
Does anyone smoke cigars in the child's house?	
Yes	7.4 ± 5.1 (7)
No	4.0 ±2.4 (267)
Does anyone smoke pipes in the child's house?	
Yes	3.7 ± 1.5 (6)
No	4.1 ± 2.6 (268)

Table 11: (cont.) Average Blood Lead Levels by Questionnaire Response, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	MEAN (µg/dl) ± S.D. (N)
Have you ever used smokeless tobacco products?	
Yes	4.6 ± 3.1 (39)
No	4.0 ± 2.5 (244)
Does child breast feed? (Only for participants ≤3yrs old)	
Yes	5.4 ± 2.5 (4)
No	4.5 ± 2.9 (130)
Does child currently take a bottle?	
Yes	4.3 ± 2.6 (34)
No	4.6 ± 2.9 (102)
Does the child play outdoors, around the house, or in the neighborhood?	
Yes	4.1 ± 2.6 (247)
No	4.0 ± 2.4 (35)
Where does child usually play outdoors around the house?	
Back yard	3.9 ± 2.4 (119)
Front yard	4.5 ± 2.9 (95)
Side yard	3.7 ± 1.8 (30)
Other	3.9 ± 2.9 (11)
Where does the child usually play (in last 90 days) when not at home?	
Neighbor's yard	3.7 ± 2.0 (48)
Playground	3.1 ± 1.8 (11)
Near or around creek or ditch	5.6 ± 0.21 (2)
On or near sidewalks or streets	3.0 ± 1.5 (9)
Park	4.8 ± 2.6 (21)
Only plays around the home	4.5 ± 3.1 (91)
Other	3.9 ± 2.3 (72)
Don't know	NA
Is the ground where the child usually plays mainly:	
Grassy	4.0 ± 2.5 (184)
Concrete/asphalt	4.3 ± 2.5 (16)
Dirt/Soil	4.8 ± 2.8 (39)
Sandbox	5.5 ± 4.7 (2)
Other	3.1 ± 1.8 (13)

Table 11: (cont.) Average Blood Lead Levels by Questionnaire Response, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	MEAN (µg/dl) ± S.D. (N)
How often does the child play in grassy area?	
None of the time	4.0 ± 3.9 (7)
Less than half the time	4.0 ± 2.2 (113)
Half the time	4.7 ± 2.4 (46)
More than half the time	4.4 ± 3.3 (25)
All the time	5.2 ± 3.8 (22)
How often does the child play on mine waste materials?	
None of the time	4.0 ± 2.3 (219)
Less than half the time	5.1 ± 4.4 (23)
Half the time	3.7 ± 2.4 (4)
More than half the time	4.3 ± 1.4 (6)
All the time	4.8 ± 0.99 (2)
Does child :	
Crawl	3.6 ± 2.7 (4)
Walk	4.6 ± 2.9 (96)
Both	4.7 ± 2.8 (31)
Neither	2.8 ± 2.7 (5)
How often does child eat food that has fallen on floor?	
Never	4.1 ± 2.6 (128)
Less than once per week	3.8 ± 2.2 (56)
Once per week	4.0 ± 2.0 (23)
Less than once per day, but more than once per week	4.7 ± 2.5 (29)
Once per day	4.6 ± 4.1 (17)
More than once per day	4.2 ± 2.3 (28)
Where does your child usually eat?	
Sitting at the table	3.8 ± 2.3 (169)
Sitting on the floor	5.2 ± 3.6 (27)
Sitting in a high chair	4.4 ± 2.7 (61)
Other	4.5 ± 2.4 (26)
Does the child often take food, snacks, candy, bottle, or pacifier with him or her outside to play?	
Yes	4.2 ± 2.5 (143)
No	4.0 ± 2.7 (136)
How often does child eat food, snacks, or candy outside during the spring, summer and fall?	
Never	4.1 ± 2.5 (10)
Less than once per month	3.8 ± 1.8 (38)
Once per month	4.5 ± 2.9 (30)
Less than once per week, but more than once per month	4.2 ± 2.8 (36)
Once per week	4.4 ± 2.9 (29)
Less than once per day, but more than once per week	4.4 ± 2.1 (13)
How often does child take bottle/pacifier out with them?	
Never	4.5 ± 2.9 (17)
Rarely	3.5 ± 2.7 (11)
Sometimes	5.9 ± 2.0 (2)
Frequently	3.9 ± 2.4 (3)
Always	2.1 ± 1.2 (5)

Table 11: (cont.) Average Blood Lead Levels by Questionnaire Response, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	MEAN (µg/dl) ± S.D. (N)
How often is the child's pacifier washed?	
Never	
Less than once per month	5.9 ± 5.9 (3)
Once per month	1.2 ± - (1)
Less than once a week, but more than once a month	5.1 ± 3.4 (2)
Once per week	3.3 ± - (1)
Less than once a day, but more than once a week	3.8 ± 2.9 (6)
Everyday	4.0 ± 2.3 (24)
Child does not have a pacifier	1.5 ± - (1)
How often does the child use a cup with lid (sipee cup), bottle or pacifier outside during the spring, summer, and fall?	
Never	3.8 ± 2.2 (108)
Less than once per week	4.1 ± 2.8 (36)
Once per week	4.2 ± 2.2 (19)
Less than once per day, but more than once per week	4.6 ± 3.5 (38)
Once per day	4.3 ± 2.2 (39)
More than once per day	4.2 ± 2.7 (42)
Are the child's hands or face usually washed before eating?	
Yes	4.1 ± 2.5 (263)
No	3.6 ± 3.0 (19)
How often does the child wash hands or face before eating?	
Never	3.5 ± 0.4 (3)
Less than once per week	2.8 ± 0.6 (3)
Once per week	1.7 ± 1.1 (2)
Less than once per day, but more than once per week	4.8 ± 4.1 (7)
Once per day	4.2 ± 2.0 (27)
More than once per day	4.1 ± 2.5 (227)
Are the child's hands or face usually washed before going to sleep?	
Yes	4.2 ± 2.6 (267)
No	3.5 ± 2.0 (15)
How often does the child wash hands or face before going to sleep?	
Never	
Less than once per week	3.0 ± 1.5 (11)
Once per week	
Less than once per day, but more than once per week	4.9 ± 2.9 (13)
Once per day	4.1 ± 2.6 (104)
More than once per day	4.2 ± 2.6 (143)
Are the child's hands or face usually washed after playing with dirt or sand?	
Yes	4.2 ± 2.6 (257)
No	3.1 ± 1.7 (20)

Table 11: (cont.) Average Blood Lead Levels by Questionnaire Response, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	MEAN (µg/dl) ± S.D. (N)
How often does the child wash hands or face after playing with dirt or sand?	
Never	3.5 ± 1.5 (4)
Less than once per week	2.6 ± 1.2 (12)
Once per week	2.9 ± 1.3 (4)
Less than once per day, but more than once per week	4.8 ± 3.8 (4)
Once per day	4.8 ± 3.4 (31)
More than once per day	4.2 ± 2.5 (206)
Has the child used a pacifier in the last 6 months?	
Yes	3.7 ± 2.3 (35)
No	4.2 ± 2.6 (232)
Does the child suck his/her thumb or fingers	
Yes	4.4 ± 2.2 (68)
No	4.0 ± 2.7 (215)
Does the child chew on their fingernails?	
Yes	4.3 ± 2.5 (73)
No	4.0 ± 2.6 (207)
Don't know	4.4 ± - (1)
Does the child have a favorite blanket or toy?	
Yes	3.9 ± 2.2 (148)
No	4.4 ± 2.9 (134)
For those answering yes, does the child carry this around during the day?	
Yes	3.8 ± 2.5 (82)
No	3.9 ± 2.1 (77)
For those answering yes, does the child put this blanket or toy in their mouth?	
Yes	3.7 ± 2.2 (62)
No	3.8 ± 2.2 (97)
How often are toys and stuffed animals washed?	
Never	3.9 ± 2.9 (57)
Less than once per month	3.8 ± 2.3 (90)
Once per month	4.2 ± 2.2 (67)
Less than once a week, but more than once a month	4.4 ± 2.2 (28)
Once per week	4.8 ± 3.4 (25)
Less than once a day, but more than once a week	4.2 ± 2.2 (8)
Everyday	6.3 ± 4.7 (5)

Table 11: (cont.) Average Blood Lead Levels by Questionnaire Response, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	MEAN (µg/dl) ± S.D. (N)
How often does the child put things other than food into their mouth ?	
Does this a lot	4.3 ± 2.3 (53)
Just once in a while	4.7 ± 3.1 (112)
Almost never	3.4 ± 2.0 (48)
Never	3.5 ± 1.7 (68)
Does the child put their mouth on furniture or on the window sill?	
Does this a lot	4.8 ± 2.8 (19)
Just once in a while	4.7 ± 3.0 (67)
Almost never	3.8 ± 2.1 (47)
Never	3.8 ± 2.4 (149)
Does the child swallow things other than food?	
Does this alot	5.6 ± 3.7 (2)
Just once in a while	5.4 ± 2.6 (17)
Almost never	4.7 ± 2.9 (47)
Never	3.9 ± 2.4 (216)
Does the child put paint chips in their mouth?	
Does this alot	
Just once in a while	6.1 ± - (1)
Almost never	3.5 ± 1.8 (7)
Never	4.1 ± 2.6 (272)
Don't know	3.7 ± 1.0 (2)
Does your household have a vegetable garden?	
Yes	3.4 ± 1.6 (36)
No	4.2 ± 2.7 (243)
For those answering yes, how often does the child eat vegetables grown in your garden?	
Once per week or more	3.4 ± 1.9 (13)
Less than once per week	4.0 ± 1.4 (7)
Never	2.9 ± 1.1 (17)
Refused	3.5 ± - (1)
Never	
Has soil been hauled in and placed on your garden?	
Yes	3.9 ± 1.0 (11)
No	4.1 ± 2.2 (12)
How often does the child eat vegetables grown elsewhere in the local area?	
Once per week or more	4.0 ±2.5 (33)
Less than once per week	4.5 ±2.9 (64)
Never	4.0 ± 2.5 (180)

Table 11: (cont.) Average Blood Lead Levels by Questionnaire Response, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

FACTOR	MEAN (μg/dl) ± S.D. (N)
Has the child ever been treated with traditional, folk, or herbal medications?	
Yes	3.7 ± 3.4 (21)
No	4.1 ± 2.5 (261)
Amount of out-of-pocket money spent each week on meat, vegetables and milk products in this household:	
≤ $25	4.4 ± 3.5 (33)
$26-$50	4.1 ± 2.5 (93)
$51-$75	3.9 ± 1.9 (73)
$76-$100	4.6 ± 3.1 (44)
> $100	3.7 ± 1.8 (38)
Refused	7.9 ± - (1)
Amount of out-of-pocket money spent each week on items other than meat, vegetables and milk products in this household:	
≤ $25	4.4 ± 2.7 (69)
$26-$50	4.0 ± 2.7 (112)
$51-$75	4.4 ± 2.6 (58)
$76-$100	3.4 ± 1.7 (25)
> $100	3.3 ± 1.9 (17)
Refused	7.9 ± - (1)
Don't know	1.9 ± - (1)
Do you receive food stamps, WIC vouchers, food from pantries, or any other programs?	
Yes	4.6 ± 2.8 (114)
No	3.7 ± 2.3 (169)

Table 12: Correlation Coefficients for Blood Lead Levels with Questionnaire Responses, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

Variable	Correlation Coefficient	p-value[1,2]	Number of Children
Questionnaire			
Age	-.189	**.001**	282
Year home built	.118	**.047**	284
How often clean kitchen	.029	.624	284
How often clean child's bedroom	.135	**.023**	284
How often dry sweep	-.045	.449	284
How often vacuum	.087	.143	284
How often mop	-.065	.273	284
How often wet wipe	-.103	**.084**	284
How often dry dust	.083	.164	284
How often use other cleaning methods	.004	.945	284
How often child play with pet	.204	**.032**	111
How often are child's hands washed after playing with pet	.168	**.086**	106
How many hours a day child plays outside (spring and fall)	.004	.952	283
How many hours a day child plays outside (winter)	.054	.369	283
How many hours a day child plays outside (summer)	.124	**.037**	283
How many hours a day child spends playing on the floor	.100	**.094**	283
How many hours a day child plays outside	.009	.881	254
How often child plays in dirt	.229	**.000**	256
How often child plays on concrete/asphalt	-.027	.668	256
How often child plays on grassy area	-.164	**.009**	254
How many times weekly is the child bathed or showered	.030	.619	283
How often child's hands or face washed after playing with dirt	-.039	.527	262
How often child's hands or face washed before going to sleep	.063	.302	271
How often child's hands or face washed before eating	.051	.407	269
How often child eats food that has fallen on the floor	.056	.347	281
How often child eats vegetables from own garden	.016	.924	38
How often child eats root vegetables from own garden	.222	.285	25
How often child eats leafy green vegetables from own garden	.161	.453	24
How often child eats vegetables from elsewhere	-.027	.659	277
How often child eats root vegetables grown elsewhere	.011	.906	119
How often child eats leafy green vegetables from elsewhere	.007	.944	118
How often child takes bottle/pacifier outside	-.244	.140	38
How often child's pacifier washed	-.148	.376	38
How often toys/stuffed animals washed	.135	**.024**	280
Highest level of education completed by head of household	-.053	.377	283
Highest level of education completed by child's mother	.130	**.059**	211
Amount of out-of-pocket money spent each week on meat, vegetables and milk	.080	.182	282
Amount of out-of-pocket money spent each week on other food items	.005	.927	283
Number of people smoking in house	.200	**.001**	280

1. Bolded significance indicates correlation at the 0.10 or less level.
2. Two-tailed significance level.

Table 13: Correlation Coefficients for Blood Lead Levels with Environmental Data, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

Variable	Correlation Coefficient	p-value[1,2]	Number of Children
Environmental Samples			
Total number of rooms in residence µg/ft^2	-.150	**.013**	275
Window Sill composite loading[3] µg/ft^2	.295	**.000**	257
Miniblind composite loading[3]µg/ft^2	.154	**.020**	226
Floor composite loading[3]µg/ft^2	.155	**.009**	283
Mean lead dust loading[3]µg/ft^2	.156	**.008**	283
Drip line soil[3] mg/kg	.218	**.000**	284
Play area soil[3] mg/kg	.080	.257	200
Yard soil[3] mg/kg	.094	.114	284
Mean soil[3] mg/kg	.094	.114	284
Outdoor wall total XRF[3] mg/cm^2	.352	**.000**	248
Porch total XRF[3] mg/cm^2	.241	**.001**	202
Outdoor structure total XRF[3] mg/cm^2	.322	**.000**	258
Mean window stool XRF[3] mg/cm^2	.240	**.000**	223
Mean miniblind XRF[3] mg/cm^2	.037	.592	208
Mean indoor total XRF[3] mg/cm^2	.157	**.009**	272

1. Bolded significance indicates correlation at the 0.10 or less level.
2. Two-tailed significance level.
3. Log transformed, mean soil levels is the average of yard, dripline, and play areas

Table 14 - Questionnaire Responses by Factors and Group, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001 (only children living in same area for both studies)

FACTOR	1991 N (%)	2000 N (%)	p-VALUE[1]
Age (years)	3.38±1.58	3.29±1.57	.824
Gender			
Male	122 (50.2)	112 (52.3)	
Female	121 (49.8)	102 (47.7)	.649
Race			
American Indian/ Alaskan Native	7 (2.9)	10 (4.7)	
Asian/ Pacific Islander	0 (0.0)	0 (0.0)	
Black	2 (0.8)	1 (0.5)	
White	233 (96.3)	194 (91.5)	
Other	0 (0.0)	7 (3.3)	
Don't know			.024
Is child Hispanic or of Spanish Descent			
Yes	12 (5.0)	22 (10.3)	
No	230 (95.0)	191 (89.3)	
Don't Know		1 (0.5)	.030
Total gross household income before taxes:			
≤ $4,999	20 (8.2)	7(3.3)	
$5,000-$9,999	19 (7.8)	15 (7.0)	
$10,000-$14,999	21 (8.6)	20 (9.4)	
$15,000-$19,999	36 (14.8)	21 (9.9)	
$20,000-$24,999	38 (15.6)	22 (10.3)	
$25,000-$29,999	34 (14.0)	18 (8.5)	
$30,000-$34,999	23 (9.5)	24 (11.3)	
$35,000-$39,999	15 (6.2)	19 (8.9)	
≥ $40,000	30 (12.3)	56 (26.3)	
Refused	1 (.4)	1 (0.5)	
Don't Know	6(2.5)	10 (4.7)	.002
Highest year of education completed by the mother of the child:			
No schooling	0 (0.0)	1 (0.6)	
Elementary School	3 (1.3)	17 (10.3)	
High School	124 (51.9)	76 (46.9)	
Four year College/Technical School	99 (41.4)	66 (40.7)	
Attended Graduate school	13 (5.4)	2 (1.2)	
Don't know			.000
Year house was built			
<1900-1909	25 (13.4)	14 (8.3)	
1910-1919	10 (5.4)	5 (3.0)	
1920-1929	17 (9.1)	9 (5.4)	
1930-1939	14 (7.5)	8 (4.8)	
1940-1949	19 (10.2)	11 (6.5)	
1950-1959	9 (4.8)	11 (6.5)	
1960-1969	19 (10.2)	9 (5.4)	
1970-1979	21 (11.3)	22 (13.1)	
1980-1989	50 (26.9)	23 (13.7)	
1990-present	2 (1.1)	56 (33.3)	
Refused (treated as missing, not included in above %)		1 (0.5)	
Don't know (treated as missing, not included in above %)	57(23.5)	46 (21.4)	.000

[1] Chi square or Fisher's Exact test used for categorical data, t-test for scaled data. Two tailed test of significance.

Table 14 – Questionnaire Responses by Factors and Group, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001 only children living in same area for both studies)

FACTOR	1991 N (%)	2000 N (%)	p-VALUE[1]
House rented or owned?			
Rented	72 (29.6)	73 (34.8)	
Owned	171 (70.4)	137 (65.2)	
Other			.243
Type of water pipes			
Lead	22 (9.11)	4(1.9)	
Plastic		110 (51.4)	
Galvanized Steel		16 (7.5)	
Copper		6 (2.8)	
Iron		1 (0.5)	
Mixed		24 (11.2)	
Other	221 (90.9)	4 (1.9)	
Don't Know		49 (22.9)	.001
What type of exterior does your home have?			
Wood	146 (60.1)	78 (36.3)	
Brick			
Block			
Mobile home			
Vinyl/Metal siding			
Other	97 (39.9)	137 (63.7)	
Refused			
Don't know			.000
Any part of house repainted, sanded, or stripped chemically or by heat within last year?			
Yes	107 (44)	82 (38.7)	
No	136 (56.0)	130 (61.3)	.248
How many total hours does your child spend at home Monday through Friday?	106.9 ± 17.4 (243)	105.8 ± 20.2 (215)	.002
How many total hours does your child spend at home Saturday and Sunday?	42.8 ± 9.2 (243)	45.7 ± 7.0 (215)	.001
How many total hours does your child spend at the babysitter (outside of home) Monday through Friday?	6.1 ± 14.2 (243)	3.4 ± 11.0 (215)	.000
How many total hours does your child spend at the babysitter (outside of home) Saturday and Sunday?	0.1 ± 0.8 (243)	0.1 ± 1.2 (215)	.402
How many total hours does your child spend at the daycare (commercial facility) Monday through Friday?	3.6 ± 11.1 (243)	5.2 ± 13.3 (215)	.006
How many total hours does your child spend at the daycare (commercial facility) Saturday and Sunday?	0.3 ± 2.0 (243)	0.1 ± 1.4 (215)	.025
How many total hours does your child spend at the other locations Monday through Friday?	3.3 ± 7.1 (243)	5.0 ± 13.0 (215)	.000
How many total hours does your child spend at the other locations Saturday and Sunday?	4.8 ± 9.2 (243)	1.8 ± 6.1 (215)	.000

[1] Chi square or Fisher's Exact test used for categorical data, t-test for scaled data. Two tailed test of significance.

Table 14 –Questionnaire Responses by Factors and Group, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001 (only children living in same area for both studies)

FACTOR	1991 N (%)	2000 N (%)	p-VALUE[1]
Does child breast feed? (Only for participants ≤3yrs old)			
Yes	5 (3.6)	3 (3.0)	.800
No	134 (96.4)	97 (97.0)	
Does the child play outdoors, around the house, or in the neighborhood?			
Yes	224 (92.2%)	186 (87.3)	
No	19 (7.8)	27 (12.7)	.086
Where does child usually play outdoors around the house?			
Back yard	80 (35.7)	92 (47.7)	
Front yard	56 (25.0)	64 (33.2)	
Side yard	80 (35.7)	26 (13.5)	
Other	8 (3.6)	11 (5.7)	.000
Where does the child usually play (in last 90 days) when not at home?			
Neighbor's yard	57 (25.4)	37 (19.3)	
Playground	7 (3.1)	7 (3.6)	
Near or around creek or ditch	2 (.9)	2 (1.0)	
On or near sidewalks or streets	11 (4.9)	8 (4.2)	
Park	27 (12.1)	19 (9.9)	
Only plays around the home	50 (22.3)	60 (31.3)	
Other	68 (30.4)	59 (30.7)	
Don't know			.403
Is the ground where the child usually plays mainly:			
Grassy	134 (59.8)	146 (76.0)	
Concrete/asphalt	14 (6.3)	10 (5.2)	
Dirt/Soil	33 (14.7)	21 (10.9)	
Sandbox	21 (9.4)	2 (1.0)	
Other	22 (9.8)	13 (6.8)	.001
Does the child often take food, snacks, candy, bottle, or pacifier with him or her outside to play?			
Yes	90 (37.0)	108 (51.2)	
No	153 (63.0)	103 (48.8)	.002
Are the child's hands or face usually washed before eating?			
Yes	211 (87.6)	200 (93.9)	
No	30 (12.4)	13 (6.1)	.021
Are the child's hands or face usually washed before going to sleep?			
Yes	221 (91.3)	203 (95.3)	
No	21 (8.7)	10 (4.7)	.092
Are the child's hands or face usually washed after playing with dirt or sand?			
Yes	231 (96.3)	193 (91.9)	
No	9 (3.8)	17 (8.1)	.049

[1] Chi square or Fisher's Exact test used for categorical data, t-test for scaled data. Two tailed test of significance.

Table 14 – Questionnaire Responses by Factors and Group, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001 (only children living in same area for both studies)

FACTOR	1991 N (%)	2000 N (%)	p-VALUE[1]
Has the child used a pacifier in the last 6 months?			
Yes	25 (10.3)	24 (11.9)	
No	218 (89.7)	177 (88.1)	.580
Does the child such his/her thumb or fingers			
Yes	50 (20.6)	47 (22.0)	
No	193 (79.4)	167 (78.0)	.718
Does the child chew on their fingernails?			
Yes	65 (26.7)	54 (25.6)	
No	178 (73.3)	157 (74.4)	
Don't know			.780
Does the child have a favorite blanket or toy?			
Yes	112 (46.1)	111 (52.1)	
No	131 (53.9)	102 (47.9)	.199
For those answering yes, does the child carry this around during the day?			
Yes	47 (42.3)	67 (55.8)	
No	64 (57.7)	53 (44.2)	.040
For those answering yes, does the child put this blanket or toy in their mouth?			
Yes	31 (27.9)	44 (39.3)	
No	80 (72.1)	68 (60.7)	.073
How often does the child put things other than food into their mouth ?			
Does this alot	52 (21.4)	37 (17.5)	
Just once in a while	83 (34.2)	83 (39.2)	
Almost never	72 (29.6)	41 (19.3)	
Never	36 (14.8)	51 (24.1)	.009
Does the child put their mouth on furniture or on the window sill?			
Does this alot	22 (9.1)	13 (6.1)	
Just once in a while	56 (23.0)	47 (22.1)	
Almost never	47 (19.3)	35 (16.4)	
Never	118 (48.6)	118 (55.4)	.408
Does the child swallow things other than food?			
Does this alot	0 (0.0)	1 (0.5)	
Just once in a while	19 (7.8)	11 (5.2)	
Almost never	63 (25.9)	40 (18.8)	
Never	161 (66.3)	161 (75.6)	.097
Does the child put paint chips in their mouth?			
Does this alot	0 (0.0)	0 (0.0)	
Just once in a while	4 (1.7)	1 (0.5)	
Almost never	4 (1.7)	3 (1.4)	
Never	234 (96.7)	207 (98.1)	
Don't know			.477

[1] Chi square or Fisher's Exact test used for categorical data, t-test for scaled data. Two tailed test of significance.

Table 14 –Questionnaire Responses by Factors and Group, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001 (only children living in same area for both studies)

FACTOR	1991 N (%)	2000 N (%)	p-VALUE[1]
Does your household have a vegetable garden?			
Yes	51 (21.0)	33 (15.6)	
No	192 (79.0)	178 (84.4)	.143
For those answering yes, how often does the child eat vegetables grown in your garden?			
Once per week or more	20 (39.2)	12 (35.3)	
Less than once per week	0 (0.0)	6 (17.6)	
Never	31 (60.8)	15 (44.1)	
Refused	0 (0.0)	1 (2.9)	.009
How often does your child eat root vegetables (such as beets or turnips) grown in your garden?			
Once per week or more	6 (11.8)	3 (12.5)	
Less than once per week	3 (5.9)	1 (4.2)	
Never	42 (82.4)	20 (83.3)	.952
How often does your child eat leafy green vegetables (such as lettuce or spinach) grown in your garden?			
Once per week or more	4 (7.8)	2 (8.7)	
Less than once per week	2 (3.9)	4 (17.4)	
Never	45 (88.2)	17 (73.9)	.139
Has soil been hauled in and placed on your garden?			
Yes	25 (49.0)	11 (50.0)	
No	26 (51.0)	11 (50.0)	
Don't know			.939
How often does the child eat vegetables grown elsewhere in the local area?			
Once per week or more	88 (36.2)	28 (13.5)	
Less than once per week	74 (30.5)	55 (26.4)	
Never	81 (33.3)	125 (60.1)	.000
How often does your child eat root vegetables (such as beets or turnips) grown elsewhere in the area?			
Once per week or more	33 (20.6)	13 (12.3)	
Less than once per week	26 (16.3)	19 (17.9)	
Never	101 (63.1)	74 (69.8)	.211
How often does your child eat leafy green vegetables (such as lettuce or spinach) grown elsewhere in the area?			
Once per week or more	52 (32.1)	17 (16.2)	
Less than once per week	31 (19.1)	24 (22.9)	
Never	79 (48.8)	64 (61.0)	.015
Has the child ever been treated with traditional, folk, or herbal medications?			
Yes	7 (2.9)	17 (8.0)	
No	235 (97.1)	196 (92.0)	.015

[1] Chi square or Fisher's Exact test used for categorical data, t-test for scaled data. Two tailed test of significance.

Table 15- Environmental Data for 1991 Study

Variable	1991 Study Group Mean ±SD (n)
Lead Dust, mg/kg	608 ±1551 (125)
Lead Paint, mg/cm^2	1.38 ±1.65 (121)
Lead Soil, mg/kg	599 ±735 (125)

Table 16: Mean Blood Lead Levels and Environmental Measurements for Soil-Remediated Homes and Not Soil Remediated Homes, Jasper County, Missouri Superfund Site 2000 Childhood Lead Exposure Study, 2001

	Soil Remediated Homes			Not Soil Remediated Homes			
	N	Mean	SD	N	Mean	SD	p value
Mean Blood Lead Levels µg/dl	68	5.14	3.10	216	3.76	2.26	.001
Window Sill Composite Loading µg/ft^2	67	850	3952	193	205	770	.189
Miniblind Composite Loading µg/ft^2	49	1682	3453	180	1203	3227	.365
Floor Composite Loading µg/ft^2	68	5.1	9.7	218	3.7	10.2	.310
Mean Lead Dust Loading µg/ft^2	68	480	1008	218	301	857	.152
Drip Line Soil Result mg/kg	68	1617	4800	219	1030	2651	.338
Play Area Soil Result mg/kg	43	200	298	159	277	298	.135
Yard Soil Result mg/kg	68	227	295	219	315	498	.170
Overall Soil mg/kg	68	803	2027	219	576	1221	.384
Outdoor Wall Total XRF mg/cm^2	65	3.7	4.2	187	1.5	3.3	.000
Porch Total XRF mg/cm^2	56	6.6	8.5	149	2.5	5.0	.000
Outside Structure Total XRF mg/cm^2	66	4.6	4.8	196	1.7	3.1	.000
Mean Window Stool XRF Result mg/cm^2	65	1.5	3.0	161	0.5	1.5	.000
Mean Miniblind XRF Result mg/cm^2	50	3.9	3.6	170	3.4	3.4	.367
Mean Indoor Total XRF Result mg/cm^2	68	1.5	1.7	213	1.0	1.5	.022

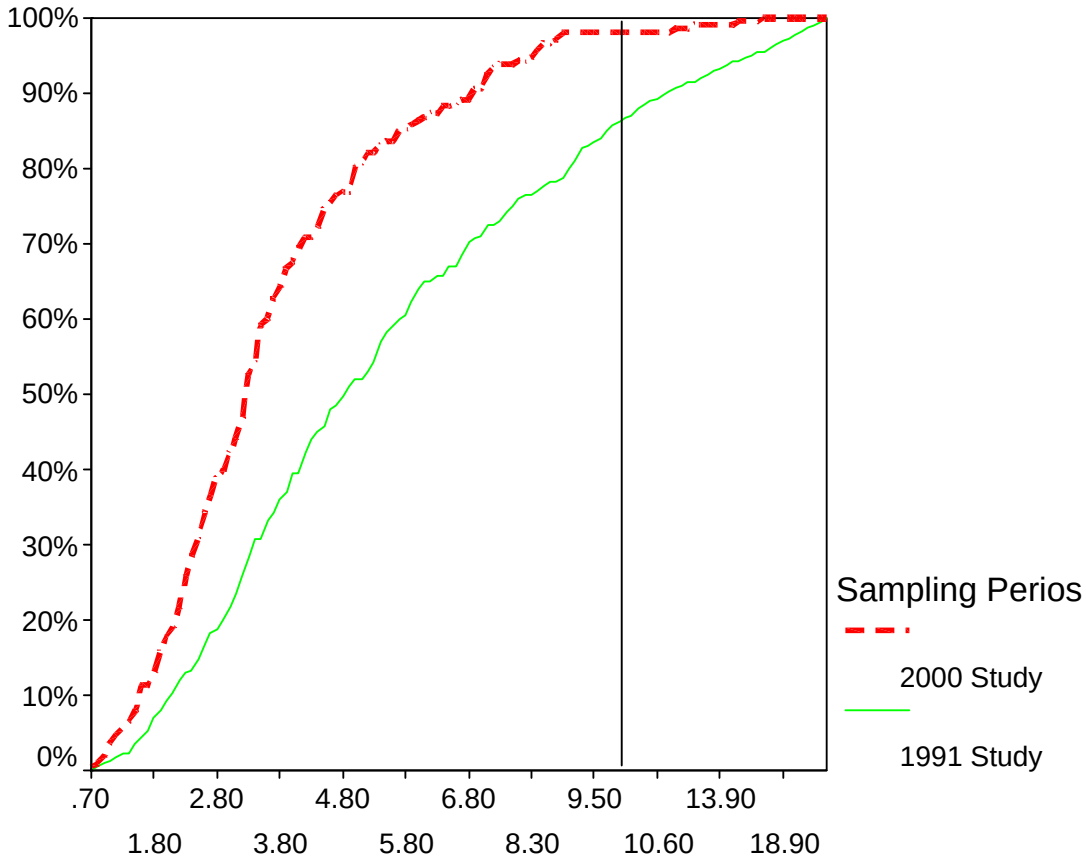

Figure 1: Cumulative frequency graph of blood lead levels for the 1991 and 2000 studies. Only children living in the area of the 1991 study are included. The perpendicular line indicates the CDC level of concern for elevated blood lead levels. 14% of the levels were above level of concern in 1991 and 2% were above level of concern in 2000.

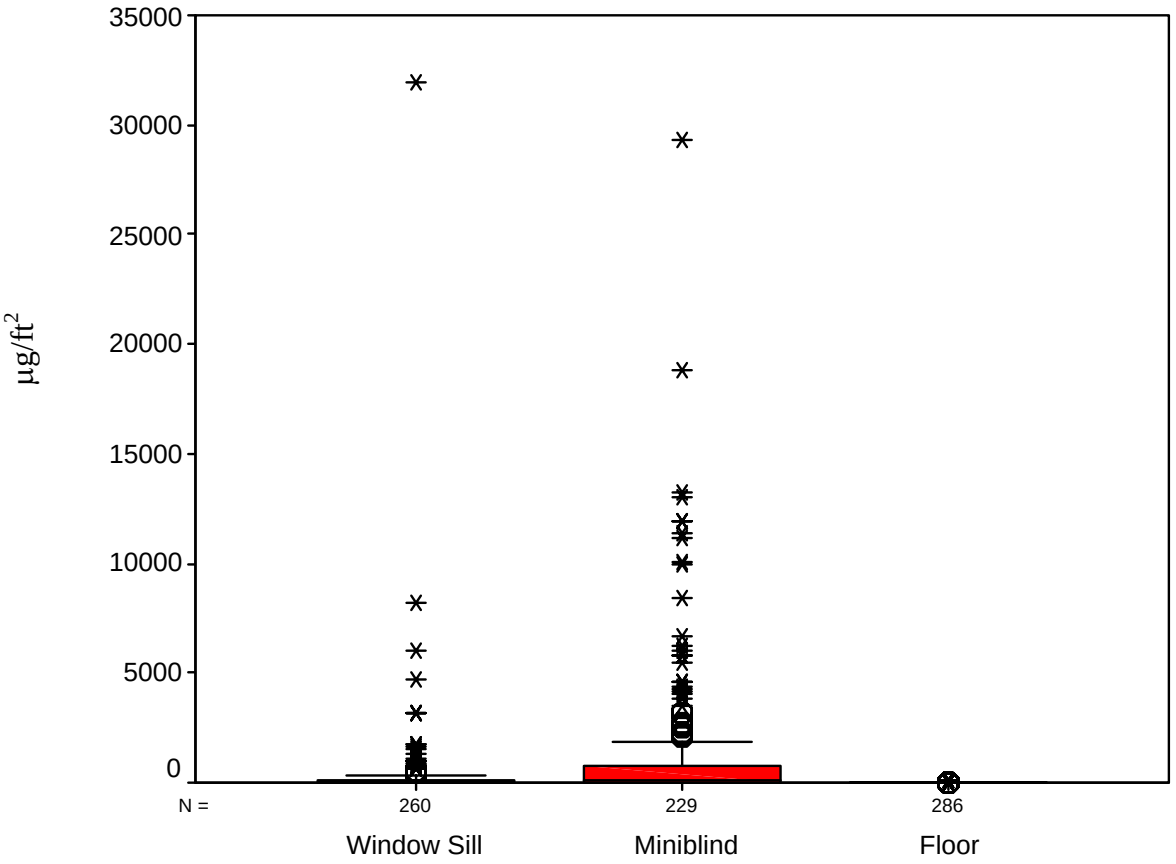

Figure 2: Boxplots of dust lead levels in 2000 for study and oversample area combined. Medians are indicated by solid line in box, interquartile ranges indicated by whiskers, outliers indicated by circles, and extreme cases indicated by asterisks. Note that the dust levels on floors was low and did not show details on this scale.

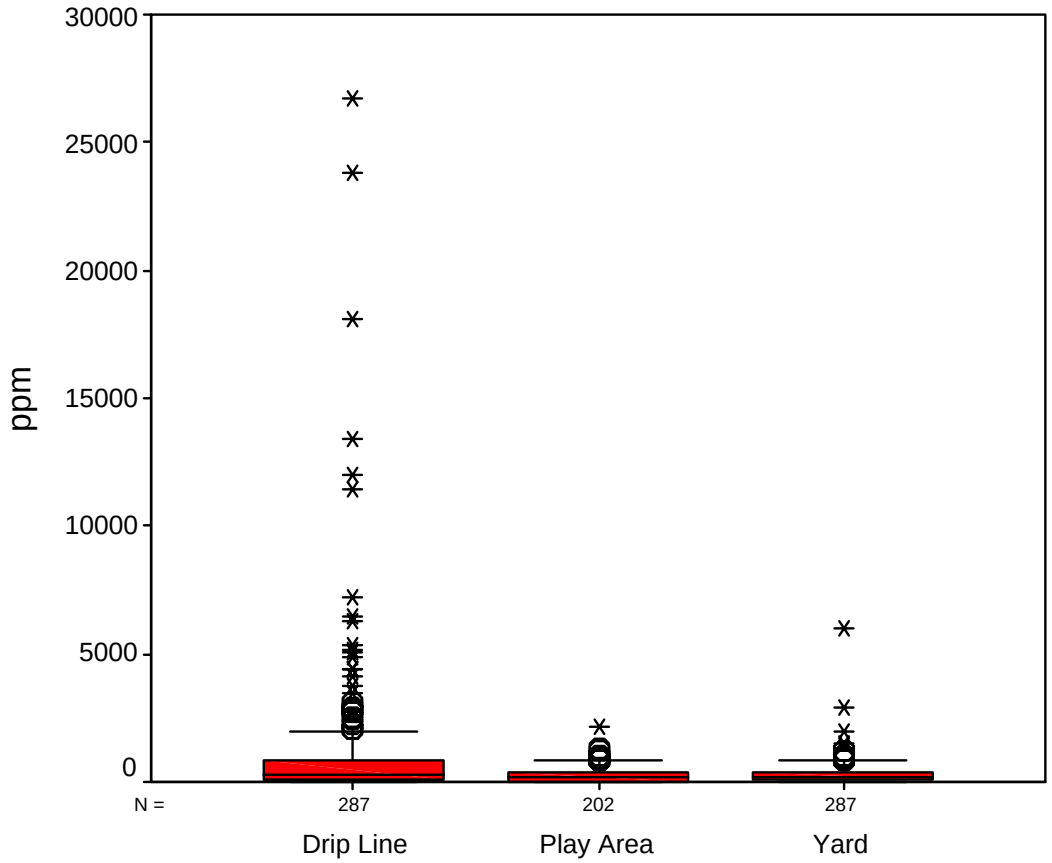

Figure 3: Boxplots of soil lead levels in 2000 for study and oversample area combined. Medians are indicated by solid line in box, interquartile ranges indicated by whiskers, outliers indicated by circles, and extreme cases indicated by asterisks.

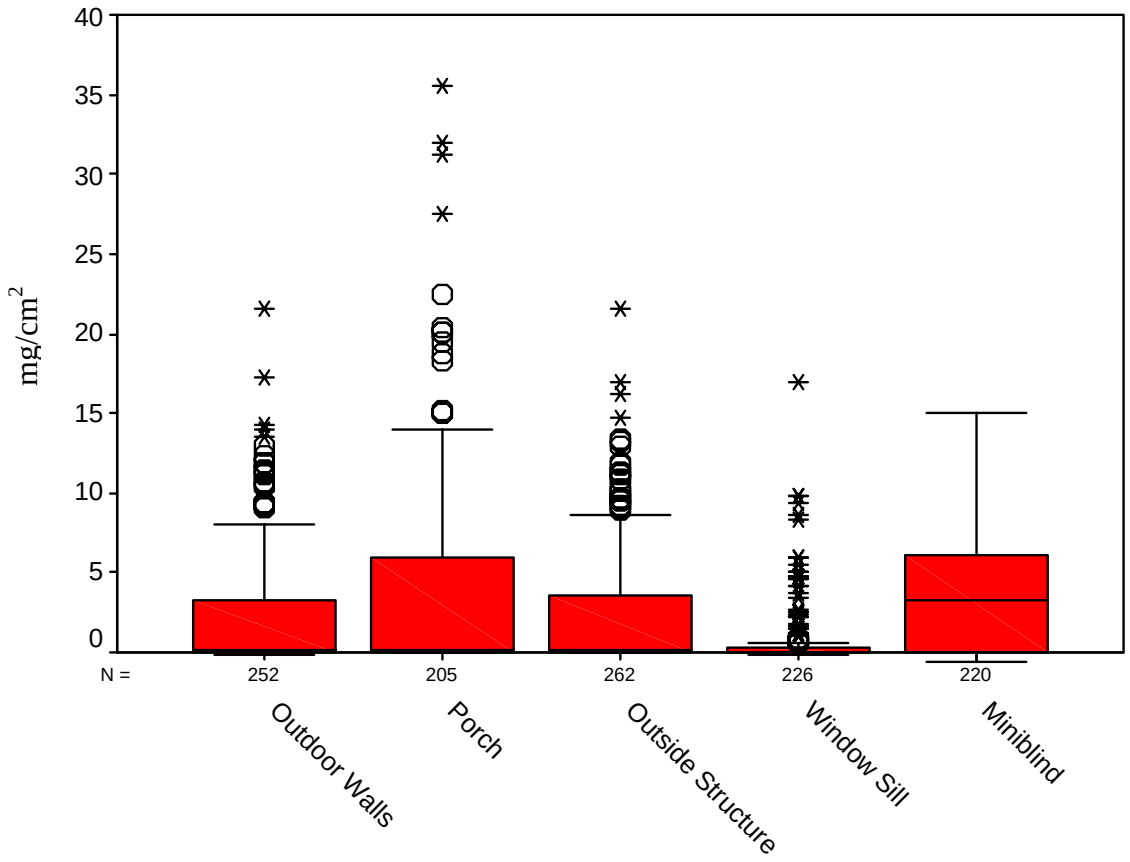

Figure 4: Boxplots of lead paint levels in 2000 for study and oversample area combined. Medians are indicated by solid line in box, interquartile ranges indicated by whiskers, outliers indicated by circles, and extreme cases indicated by asterisks.

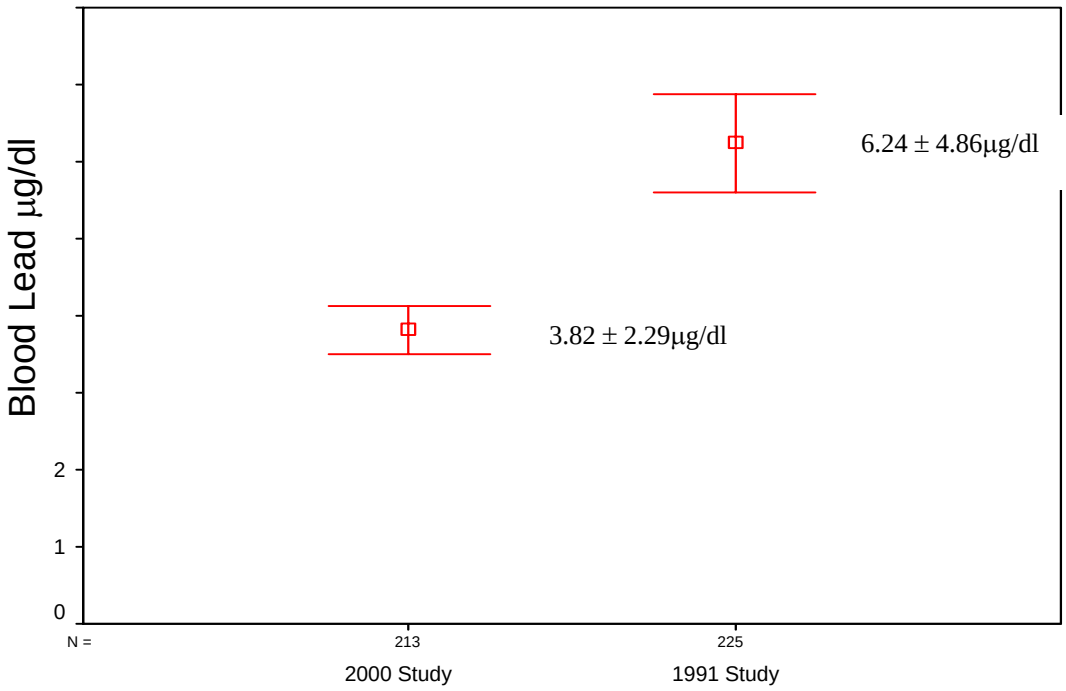

Figure 5: Mean and 95% confidence intervals for blood lead levels of children in the 1991 and 2000 study. Only children living in the 1991 study geographical area are included.

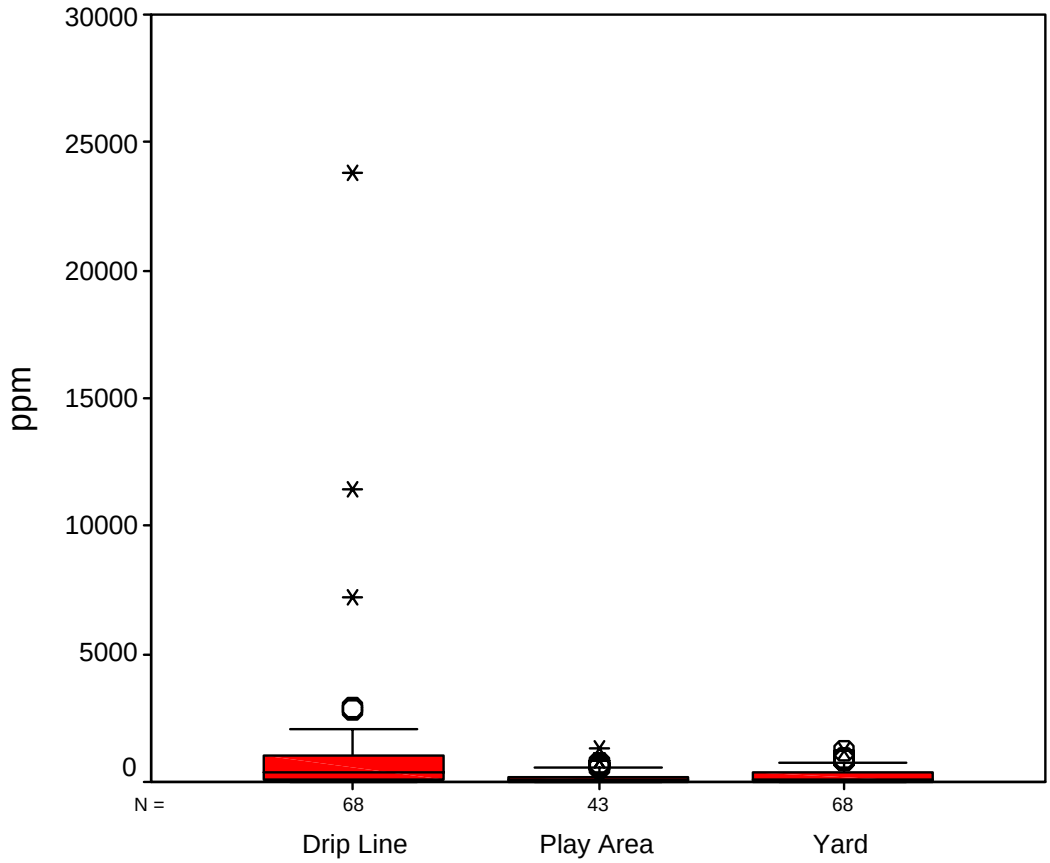

Figure 6: Boxplots of soil lead levels for soil-remediated homes from the 2000 study. Medians are indicated by solid line in box, interquartile ranges indicated by whiskers, outliers indicated by circles, and extreme cases indicated by asterisks.

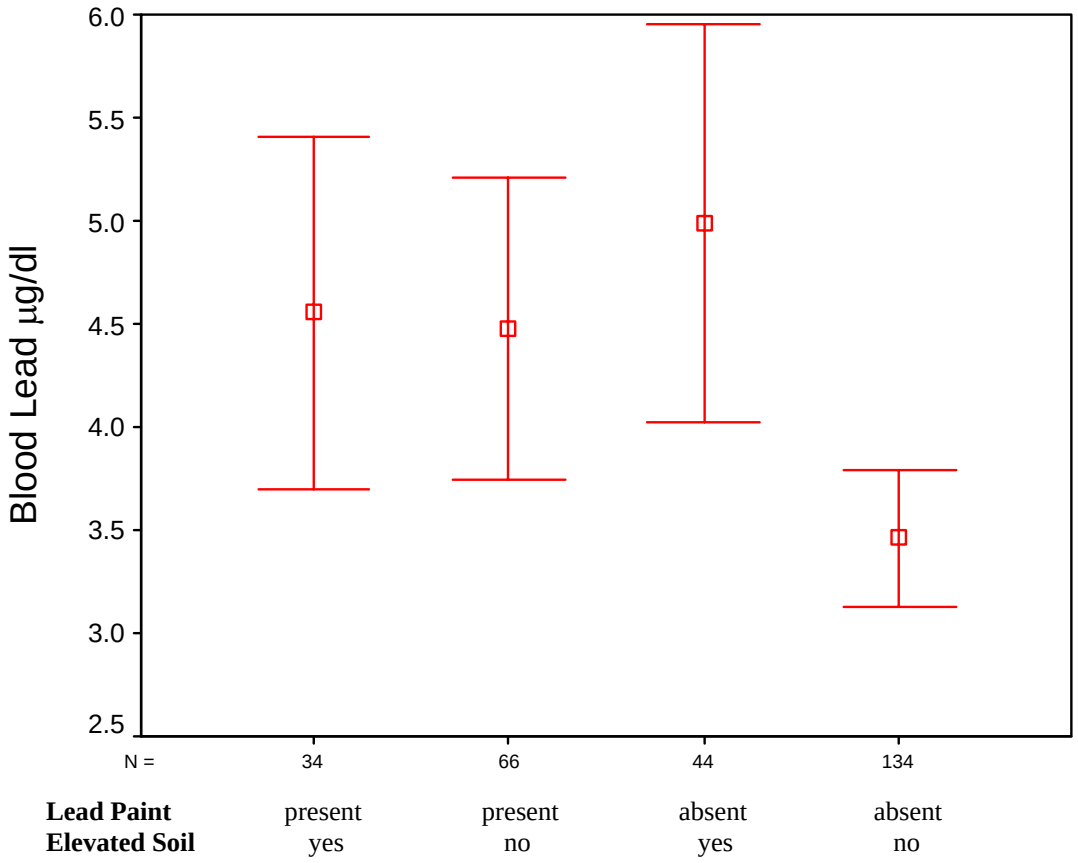

Figure 7: Average blood lead levels and 95% confidence intervals for children during the 2000 study living in homes with or without interior lead based paint and dripline soil lead levels less than or greater than 800 ppm.

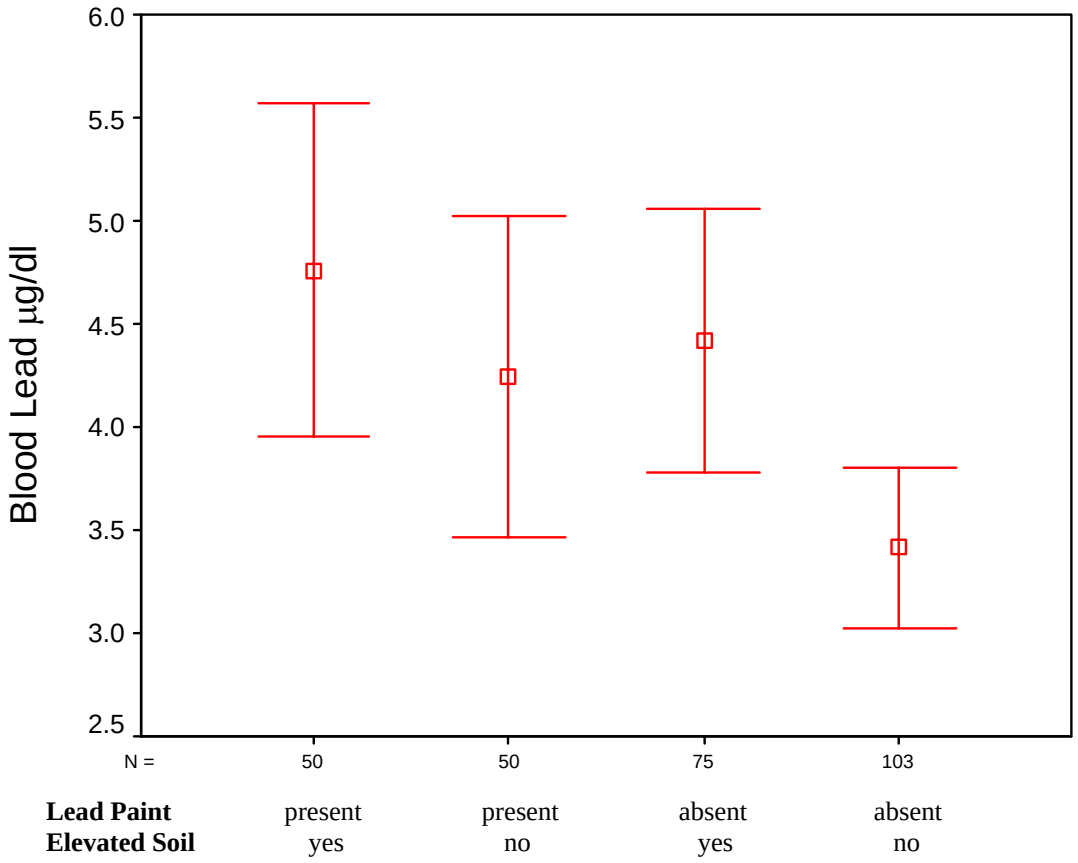

Figure 8: Average blood lead levels and 95% confidence intervals for children during the 2000 study living in homes with or without interior lead based paint and dripline soil lead levels less than or greater than 400 ppm.

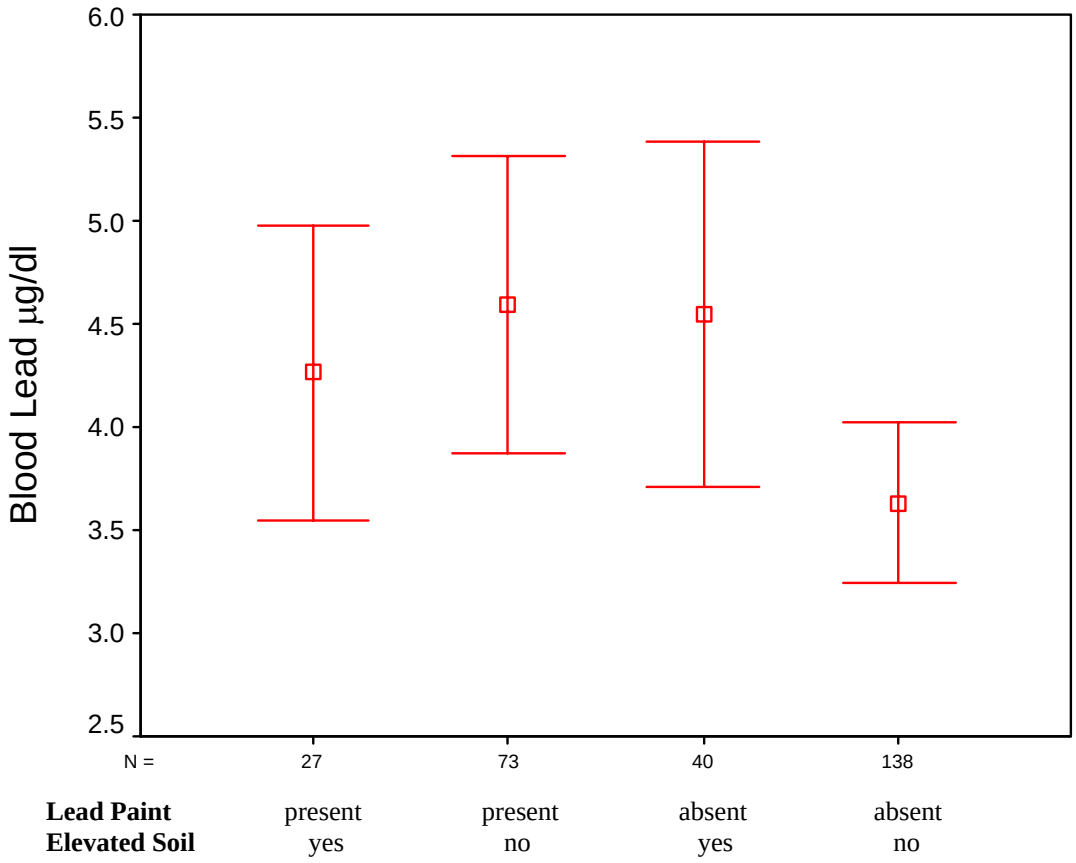

Figure 9: Average blood lead levels and 95% confidence intervals for children during the 2000 study living in homes with or without interior lead based paint and yard soil lead levels less than or greater than 400 ppm.

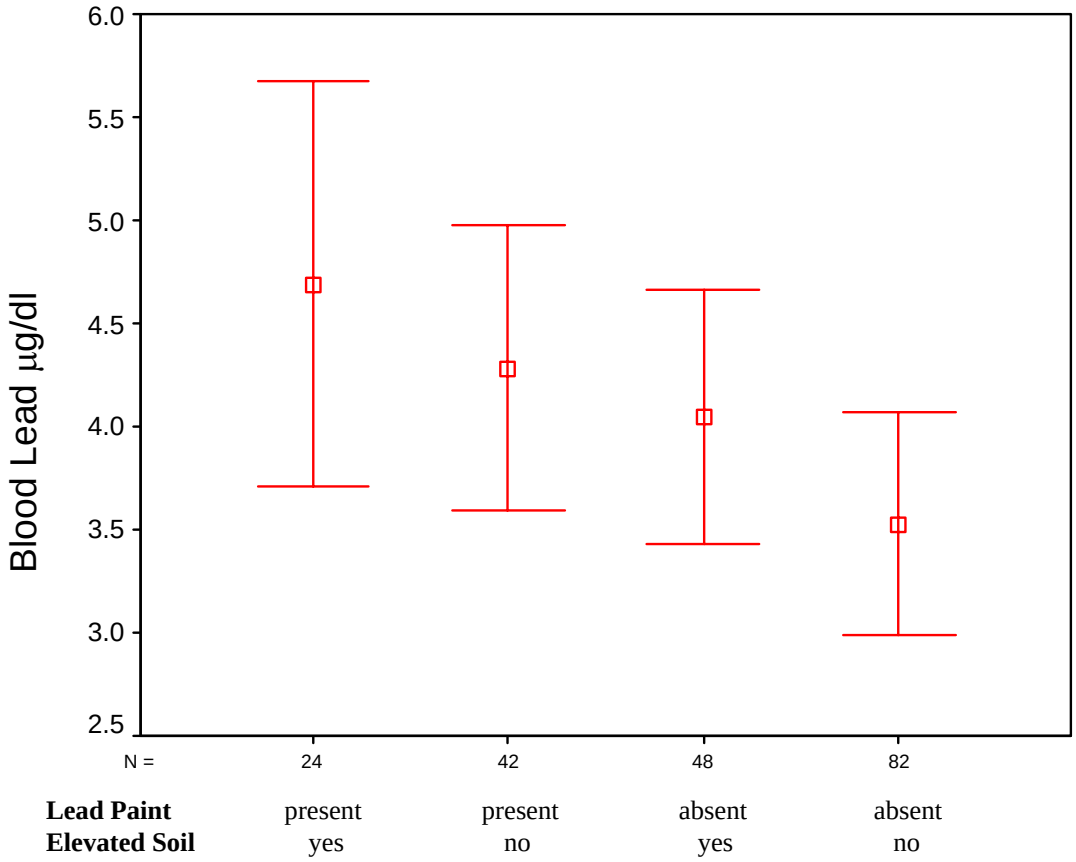

Figure 10: Average blood lead levels and 95% confidence intervals for children during the 2000 study living in homes with or without interior lead based paint and play area soil lead levels less than or greater than 250 ppm.

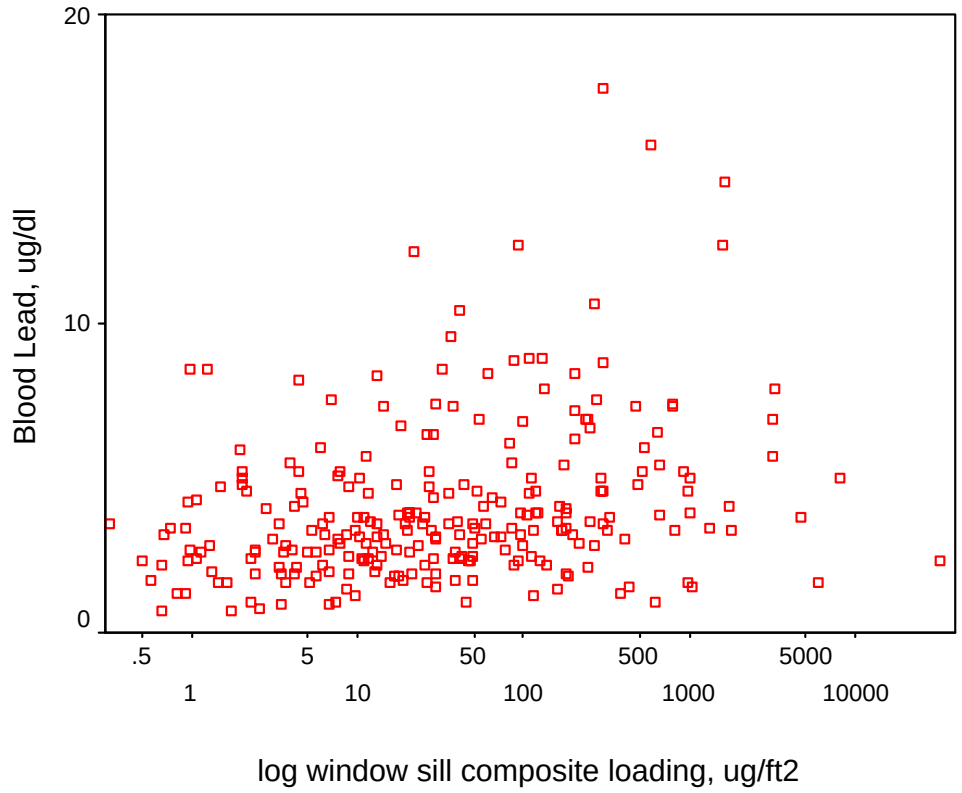

Figure 11: Scatterplot of blood lead levels and log of window sill composite dust wipe samples during the 2000 study.

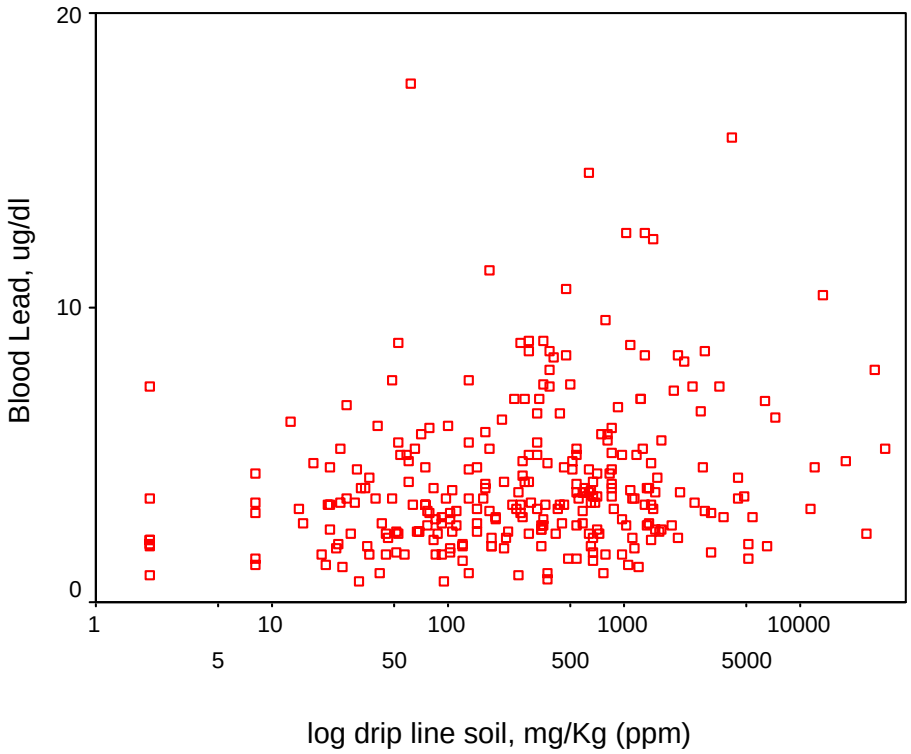

Figure 12: Scatterplot of blood lead levels and the log of drip line soil lead levels during the 2000 study.

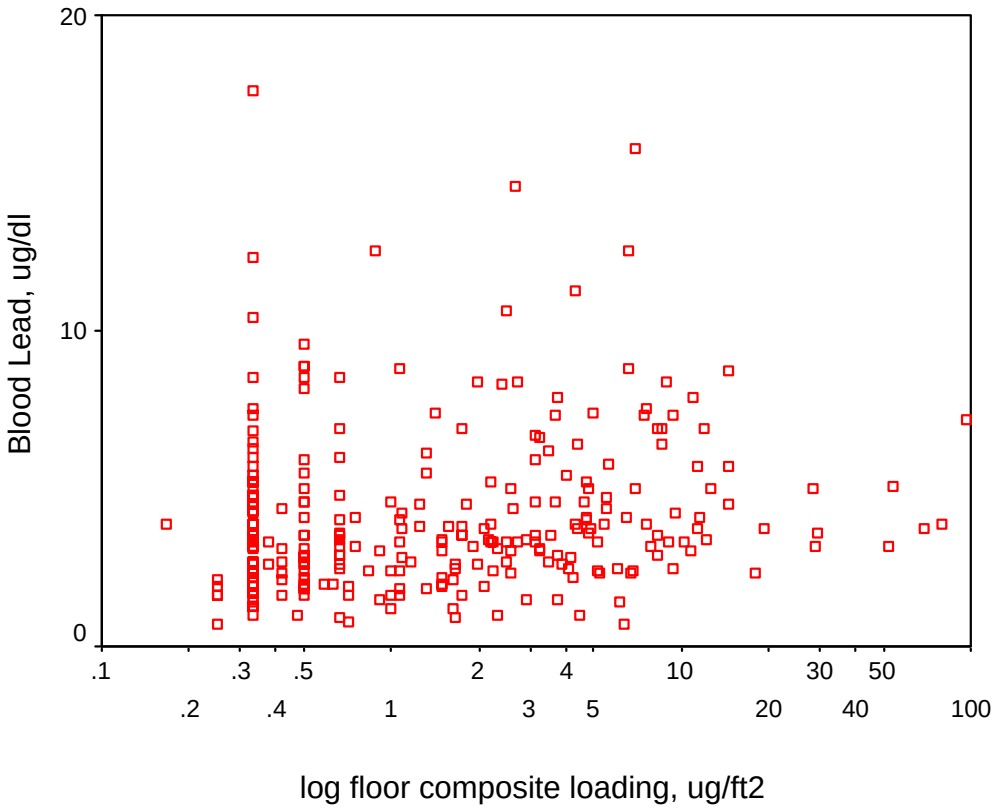

Figure 13: Scatterplot of blood lead levels and log of floor composite loading dust lead levels during the 2000 study.

APPENDICES