Agency for Toxic Substances and Disease Registry
Division of Health Studies

LEAD AND MERCURY EXPOSURE SCREENING OF CHILDREN IN POMPTON LAKES

MARCH 1998

DEPARTMENT OF HEALTH & HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
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LEAD AND MERCURY EXPOSURE SCREENING OF CHILDREN IN POMPTON LAKES

A Site-Specific Follow-Up Health Study

Prepared by Michael Berry, M.P.H.

New Jersey Department of Health and Senior Services
Division of Environmental and Occupational Health Services
Consumer and Environmental Health Services

MARCH 1998

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ABSTRACT

In the summer of 1994 the New Jersey Department of Health and Senior Services conducted a lead and mercury biological screening of children living in the Borough of Pompton Lakes. The purpose of the screening was to evaluate the potential exposure to children living in a community impacted by an industrial source with years of contaminant runoff.

Environmental testing found significant lead and mercury concentrations in off-site soils of a residential neighborhood adjacent to the industrial facility. Blood-lead and urine-mercury were selected as the biomarkers for determining recent exposure to these metals. Biological specimens were collected at two different points in time and separated by about six weeks from June to August. The purpose of screening twice was to evaluate seasonal changes and duration of exposure.

A questionnaire was administered to aid in providing information on potential exposure routes and additional risk factors for exposure. The questionnaire also asked twelve health outcome questions of the participants focused primarily on self-reported diagnosed developmental, behavioral, and neurological conditions.

Children from throughout Pompton Lakes were solicited to participate in the screening. Children residing in the Acid Brook neighborhood were designated exposed while children residing in other parts of town were designated the unexposed controls.

A total of 218 children from 114 households participated in at least one of the two screening sessions. The percentage of first session participants returning for the second session was 62%. A total of 81 children (37%) lived in the exposed area.

Children in the exposed area had an average blood-lead of 2.5 μg/dl during the first screening and 3.1 μg/dl during the second screening. None of the children in the exposed area had a blood-lead level over 10 μg/dl. Average blood-lead levels in the control children were slightly lower but not significantly different than the exposed children. Only one of the control children had a blood-lead level above 10 μg/dl. With the exception of one control child, none of the urine-mercury tests were above the limit of detection (0.4 μg/l).

The health outcome information, as reported by the parents, found that living in the exposed area was significantly associated with learning disorders (OR = 3.1; 95%; CI = 1.3, 7.2) and aggressiveness (OR = 3.6; 95% CI = 1.1, 12.4). Seven other health indicators were elevated for the exposed children though not significantly.

The screening did not find evidence of unusual current exposure to lead and mercury in children tested. However, based on self-reported information, there is evidence of increased health complaints in children in the exposed area. Consequently, it is recommended that a medical records review should be consider in order to validate these results.

LEAD AND MERCURY EXPOSURE SCREENING OF CHILDREN IN POMPTON LAKES

INTRODUCTION

The following report describes an exposure screening of children conducted by the New Jersey Department of Health and Senior Services (DHSS). The screening was in response to recommendations of the federal Agency for Toxic Substances and Disease Registry (ATSDR) for a community investigation of the population living near a heavily contaminated industrial site in Pompton Lakes (ATSDR, 1994). ATSDR's evaluation of the site identified numerous potential routes of exposure to nearby residents. Because of the concern that children in the community could be currently exposed to heavy metals, the DHSS decided to conduct this exposure screening.

The DuPont Pompton Lakes Works (PLW) is a 580 acre site located in the northwest section of the Borough of Pompton Lakes, Passaic County. The PLW has been an explosives manufacturing operation since 1886 and was acquired by DuPont in 1902. During its long operational history, the PLW produced black powder, smokeless powder, blasting caps, detonating fuses, mercury fulminate, boosters, primers, rocket igniters, bullets, grenades, and lead azide. Production of these materials resulted in generation of various wastes. Waste disposal on-site included lead salts, mercury compounds, explosive powders, chlorinated solvents, waste wire drawing solutions, and detonated blasting caps (ATSDR, 1994). Over 100 waste disposal areas have been identified on the PLW grounds (Dunn Geoscience Corp., 1991).

Waste management practices over time have resulted in significant contamination of surface water, groundwater, soil, and sediment both on and off the PLW property. The Acid Brook is a stream that flows from the PLW site through a residential area adjacent to the PLW site, known as the Acid Brook Area, and empties into Pompton Lake. Hazardous levels of lead and mercury migrated from the site via the Acid Brook to contaminate off-site soils in the adjoining neighborhood. The highest levels of lead and mercury were detected along the banks of the Acid Brook with a maximum lead level of 119,000 parts per million (ppm) and maximum mercury level of 8,060 ppm (ATSDR, 1994). The highest soil contamination levels found on residential properties were 62,000 ppm lead and 540 ppm mercury.

The Agency for Toxic Substances and Disease Registry's Public Health Assessment for the site identified multiple completed exposure pathways including residential surface soil contact, Acid Brook soil and sediment contact, surface water contact, private well water contact, and food chain contact through ingestion of local fish and garden vegetables (ATSDR, 1994). Current and future human exposure to lead and mercury continues to be possible through the above mentioned pathways. Consequently, ATSDR concluded that the PLW is a major public health hazard because of human exposure to contaminants in soil, sediment, surface water, ground water, and fish in the Acid Brook area (ATSDR, 1994).

Lead is a poison that affects virtually every system in the body. It is particularly harmful to the developing brain and nervous system of fetuses and young children (CDC, 1991; ATSDR, 1990). Very severe lead exposure in children (blood lead levels > 80 μg/dl) can cause coma, convulsions, and even death. Lower levels cause adverse effects on the central nervous system, kidney, and hemopoietic system. Blood lead levels as low as 10 μg/dl, which do not cause distinctive symptoms, are associated with decreased intelligence and impaired neurobehavioral development. Many other effects begin at low exposure levels, including decreased stature or growth, decreased hearing acuity, and decreased ability to maintain a steady posture.

Mercury, in both the organic and inorganic forms, is highly toxic. In general, the nervous system and kidney are the primary target organs of mercury exposure (ATSDR, 1992). Tremors of the upper extremity are common and may involve other parts of the body. Occupationally exposed workers have reported a variety of symptoms including irritability and loss of ambition. Mercury concentrates in the kidney and may damage the basement membrane of the glomeruli. Mercury binds avidly to the sulfhydryl group on proteins and is very disruptive to many enzymatic and other protein functions. Mercury also interferes with cell division.

In response to the potential health implications of heavy metal exposure in the community, the DHSS developed a community exposure screening of children in Pompton Lakes. The purpose of screening children (the highest risk population) was to assess the current potential exposure to lead and mercury utilizing biological monitoring of blood and urine. The intent of the screening was to 1) identify children with high levels in order to intervene and reduce exposures and 2) quantitatively evaluate residential proximity to the site with the biomedically measured levels.

Blood-lead and urine-mercury were selected as the two most appropriate biomarkers for determining recent exposure to lead and mercury. Measurement of these two markers provides accurate information on exposure as recent as a few weeks prior to testing. Erythrocyte protoporphyrin was also measured in an attempt to provide evidence of longer-term or chronic exposure to lead. However, there are no validated and accurate testing methods for determining the extent of children's exposures years ago. Although this screening cannot evaluate distant past exposures, the biomarkers selected can provide evidence of current exposure to children that needs to be eliminated.

METHODS

The eligible study population for the Pompton Lakes lead and mercury screening includes all children residing or going to school in Pompton Lakes. The size of the eligible population is estimated to be about 2,500 children with approximately 20 percent living in the Acid Brook area (US Census Bureau, 1990). The screening project actively recruited all children in Pompton Lakes and was prepared to screen every child wishing to participate.

A primary goal of statistical analysis is to detect systematic influences in the presence of random variation. The likelihood that a statistical technique correctly detects nonrandom effects is

called power. The screening project anticipated enrolling a minimum of 200 children in order to provide a reasonable power for detecting significant differences of metal body burden in the population. Assuming half of those participating resided in the exposed neighborhood, the study had a power of 95 percent to detect a 1 microgram per deciliter (μg/dl) average increase in blood-lead and an 80 to 90 percent power to detect a two- to three-fold increase in the proportion of children with blood-leads above 10 μg/dl (Kelsey, Thompson and Evans, 1986). Because very little is known about background levels of mercury in children, power could not be calculated for mercury. A representative sample of Acid Brook children as well as non-Acid Brook children (controls) were sought for the screening.

Outreach to prospective children was accomplished via three routes. The first outreach strategy was a mailing to parents of children attending the local public schools (Pompton Lakes School District) and one parochial school (St. Mary's Elementary School). Second, parents of children attending four preschool day care centers in Pompton Lakes were invited to have their children participate in the screening. The last outreach strategy was a door-to-door leafleting of homes in the Acid Brook area.

In order to maximize the participation rate in the screening program, DHSS staff worked closely with the local health department and school officials to notify and inform the community on the benefits of participating in the screening. Concurrent with the outreach activity, a survey was also conducted to measure the level of interest of the community for participating in the screening. If the survey revealed that the community was not interested in participating in the screening then the services would not be offered. The survey also sought information as to the best times (weekday vs. weekend and morning vs. afternoon vs. evening) to schedule appointments. A public meeting was also held to discuss the screening and answer questions from parents of prospective participants.

Two testing sites in the center of Pompton Lakes were selected for screening participants. The first site consisted of office space in Borough Hall and the second site was in a gymnasium of the Lenox public elementary school. The sites were next to each other on Lenox Avenue. Due to the constraints on space availability, two separate sites were utilized for the screening. The testing sites operated from Monday through Saturday and offered morning and evening hours. Appointments were scheduled in advance to reduce the waiting time of any participant during the screening. Those participants who were unable to make it to their scheduled appointment were either rescheduled or encouraged to come at any convenient time the screening sites were open. The test results were immediately sent to each participant's parent or guardian upon completion of the laboratory analysis.

Two biological media (blood and urine) were collected and analyzed to determine the extent of exposure to lead and mercury. Urine and blood were collected at two different points in time for each participant. The first screening was conducted during the last week of June 1994. The second screening was conducted approximately four to six weeks after the first, in mid-August. This sampling timeframe assures measurement during the time of year when children spend the greatest amount of time outdoors, thereby maximizing potential exposure pathways. The purpose of screening twice was to evaluate seasonal changes and duration of exposure.

Laboratory services were provided by the DHSS Public Health and Environmental Laboratories. Exposure to lead was evaluated using blood. Blood specimens were collected by venipuncture and transported to the DHSS laboratory the same day that they were collected. Each blood specimen was evaluated for blood-lead concentration and erythrocyte protoporphyrin level. Trained phlebotomists were hired to draw the blood specimens.

The blood-lead analysis was performed using graphite furnace atomic absorption spectroscopy (GFAAS) with a limit of detection of 0.3 μg/dl. The erythrocyte protoporphyrin test was conducted using the hematofluorometer technique. Quality control for the GFAAS was accomplished using a standardized aqueous dilution of certified custom-grade solution. A five point calibration curve which frames normal and elevated blood-lead values was generated. The standard curve had to have a correlation coefficient of 0.955 or better. Two blood-lead controls (at normal and elevated levels) were analyzed after the standard calibration and after the analysis of every eleven samples. A duplicate sample was analyzed for every twenty samples and had to be within twenty percent of the original sample.

Exposure to mercury was evaluated using urine. First morning urine specimens were collected in acidified containers and refrigerated until transported to the DHSS laboratory along with the blood specimens. The mercury analysis was performed using the cold-vapor atomic absorption spectroscopy technique with a detection limit of 0.4 μg/l. For quality control of the mercury test, a set of six standards prepared in the same manner as the samples were analyzed and used for the generation of a calibration curve. A laboratory blank, low level, and high level control were analyzed after the standards and at the end of the sample run. A calibration check sample was analyzed with every ten samples. Commercially available reference standards consisting of freeze-dried urine with mercury at normal and elevated levels were prepared and analyzed. Creatinine and specific gravity were also analyzed in order to standardize the mercury levels to the urine concentration.

A questionnaire was developed and administered to aid in providing information on potential exposure routes and additional risk factors for exposure (see Appendix A). Additionally, the questionnaire asked twelve health outcome questions of the participants focused primarily on self-reported diagnosed developmental, behavioral, and neurological conditions. The questionnaire was pre-tested and administered by trained DHSS staff.

A database file was developed for all data entry and management of the study information. To ensure quality assurance/quality control, a 20 percent random sample of participants' information was independently rechecked for accuracy of data entry. Additionally, frequency tabulations were done for all fields in order to identify outliers or unacceptable values.

Comparisons were made between children living closer to the site (exposed) and children living further from the site (unexposed). For purposes of the study, the exposed area was defined as residences bounded by the Wanaque River, Lakeside Avenue, Pompton Lake, and the PLW site (see Figure 1).

The distributions, means, and standard deviations of blood-lead, erythrocyte protoporphyrin (EP), and urine-mercury levels were generated and compared for the exposed versus unexposed populations. Both arithmetic and geometric means were calculated, however, only the arithmetic mean analysis is presented since the results were parallel. Data from each screening period was evaluated separately as well as the changes between screening periods. Potential confounding variables were summarized and evaluated for exposure group by chi-square. T-tests were used to assess the statistical significance of mean differences between the groups.

An unadjusted analysis was performed comparing the potential risk factors and health outcome indicators for the two areas using odds ratios (Breslow and Day, 1980). The odds ratio is a comparison of the relative odds of having a specific characteristic between the exposed and unexposed groups.

Multiple regression was used to analyze the differences in biological levels of the metals between the two areas (Cohen and Cohen, 1983; Snedecor and Cochran, 1980). All regression analyses included the residence and play area exposure variables and the potential confounding variables detected from the questionnaire. These other variables include age, sex, recent fish consumption, age of residence, recent home remodeling, potential for exposure to paint chips, potential for exposure to heavy metals, and recent use of prescription medications for skin problems that contain mercury.

Separate analyses were conducted on the dependent variables and the natural logarithm of the dependent variables; however, since the results were parallel, the results of the natural logarithm analyses are not presented in this report. Significance tests were standard t-tests based on the coefficients and their standard errors (Breslow and Day, 1980). In all analyses, a result was considered statistically significant if a two-tailed p-value was less than 0.05.

RESULTS

PARTICIPATION

A total of 218 children from 114 households participated in at least one of the two screening sessions. The study population was nearly equally comprised of males and females (50.5% males) and ranged in age from 1 through 19. The distribution of children tested by age group was 22.5% (49) under six years of age, 40.4% (88) between six and ten years of age, and 37.1% (81) over ten years of age. With the exception of three Asian children, all participants were white.

Of the total participants, 213 children attended the first session conducted during the last week of June 1994. A total of 201 blood-lead samples and 201 urine-mercury samples were collected during the first screening. The number of participants providing both blood and urine samples was 189 (88.7%).

A total of 138 children participated in the second screening session conducted in mid-August 1994. There were 133 children returning for re-evaluation and five new children that did not attend the first session. The percentage of first session participants returning for the second session was 62.4% (133 of 213). Nearly all of the second session participants provided both blood and urine samples (134 of 138). Four participants did not provide blood samples.

POTENTIAL ENVIRONMENTAL EXPOSURES

Out of the entire study population, a total of 81 (37.2%) participating children resided near the PLW site or Acid Brook, the areas designated as "exposed." Of the children in the exposed area, 90.1% lived in their current residence, or another residence in the exposed area, for at least one year prior to testing. None of the children currently residing in the unexposed area had a history of ever living in the exposed area.

The return proportion for children participating in the first screening session was 72.5% (58 of 80) for residents from the exposed area and 56.4% (75 of 133) for residents from the unexposed area. Although the exposed area's return proportion was higher than the unexposed area, they were not significantly different from each other (Odds Ratio [OR] = 1.29; 95% Confidence Interval [CI] = 0.83, 2.00).

Table 1 presents information collected by questionnaire on other potential lead and mercury exposure factors and stratified by residential location relative to the PLW site. Living closer to the site was strongly associated with the likelihood of playing near the site or Acid Brook (OR = 5.38; 95% CI = 2.94, 9.86) and living in or visiting homes where soil remediation had occurred (OR = 11.18; 95% CI = 5.25, 23.77). Also significantly associated was the odds of living near the site and the likelihood of consuming food or bottles outdoors (OR = 1.97; 95% CI = 1.11, 3.49). None of the other exposure odds ratios were statistically significant.

BIOLOGICAL TESTING RESULTS

Lead

During the first screening period, 79 children from the exposed area provided a blood sample. The blood-lead concentration for these children ranged from 0.5 µg/dl to 8.2 µg/dl with an average value of 2.5 µg/dl. The blood sample return proportion for children in the exposed area was 73.4% (58/79). The total number of exposed area blood samples collected during the second screening period was 59. The exposed area's blood-lead concentration range for the second screening was 1.0 µg/dl to 8.9 µg/dl with an average value of 3.1 µg/dl. The average EP levels for the two screening periods were 14.6 µg/dl (range = 7 µg/dl to 36 µg/dl) and 15.4 µg/dl (range = 6 µg/dl to 34 µg/dl), in June and August respectively. None of the children exceeded the federal Centers for Disease Control and Prevention's (CDC) blood-lead guideline of 10 µg/dl (CDC, 1991).

For children residing in the unexposed area, 122 blood samples were collected during the first screening period and 75 during the second screening. The blood sample return proportion was

57.4% (70/122). The average blood-lead concentrations for the unexposed children were 2.3 µg/dl (range = 0.3 µg/dl to 12.7 µg/dl) and 2.7 µg/dl (range = 1.0 µg/dl to 7.7 µg/dl), in June and August respectively. The average EP levels for the unexposed group during the two screening periods were 15.4 µg/dl (range = 7 µg/dl to 40 µg/dl) and 15.1 µg/dl (range = 5 µg/dl to 58 µg/dl). One of the children in the unexposed area exceeded the CDC's blood-lead guideline. The questionnaire for the child with the elevated blood-lead did not provide any insight as to why the elevation existed.

Table 2 summarizes average blood-lead concentrations by age group for all children providing blood samples during both screening sessions. In general, the younger age groups had significantly higher average blood-lead levels than the older age groups at the beginning of the study. Average blood-lead levels for all age groups increased slightly by the second screening. Although the average blood-lead change over the study period was not significantly different by age group, the percentage change increased from the younger to older age groups (13%, 29%, 15%, and 68%). When age groups were stratified by residential nearness to the PLW, average blood-lead levels were similar within the age group. No significant differences in EP levels were detected for the age groups.

Tables 3-5 provide the results of the statistical assessment of the average blood-lead and EP levels by residential exposure variable, play exposure variable, and consumption of locally grown vegetables variable by screening period. The average individual change between the two screening periods for each variable is also evaluated. Although the average blood-lead concentration is higher for children in the residentially exposed area during both screening periods, the average values are not statistically significantly different for the exposure groups. Based on a sample size of 79 (the children living in the exposed area), the study had a power of 88.7 percent to detect a 1 µg/dl average increase in blood-lead between the groups. The exposure variables "plays near the PLW site" and "eats locally grown vegetables" displayed no significant or consistent differences for average blood-lead levels. No significant differences in EP levels were detected for the two groups for any of the exposure variables.

Table 6 presents the multiple regression results for the blood-lead level, the EP level, and the individual change occurring between the August and June testing period. For all regression analyses, neither of the independent exposure variables of interest, living near the PLW or playing near the PLW, showed any significant association with blood-lead or EP levels.

Mercury

During the first screening period, 76 children from the exposed area provided a urine sample. The urine sample return proportion for children in the exposed area was 75.0% (57/76). Two children from the exposed area that did not provide a urine sample in June did provide one in August. A total of 125 children from the unexposed area submitted a urine sample in June. The return proportion for unexposed children was 56.8% (71/125) while 8 new children provided urine samples from the unexposed area.

With the exception of one child (from the unexposed area), none of the urine-mercury tests were above the limit of detection (0.4 µg/l). Consequently, statistical analysis of urine-mercury was not conducted.

HEALTH OUTCOME INFORMATION

The questionnaire solicited information from participants concerning 12 health indicators. Table 7 presents a summary of the health indicator data. Nine of the odds ratios for the exposed area were elevated. Living closer to the site was statistically significantly associated with two different reportedly diagnosed conditions: learning disorders (OR = 3.08; 95% CI = 1.32, 7.16) and aggressiveness (OR = 3.62; 95% CI = 1.05, 12.42). An odds ratio could not be calculated for kidney disorders since one of the frequency cells was zero.

Blood-lead and EP concentrations were also evaluated for the 12 health indicator responses. Average blood-lead and EP levels were similar for those participants reporting the existence of a health indicator relative to those who did not.

DISCUSSION

Biological measures: The results of this study indicate that the participating Pompton Lakes children did not have current exposures to lead or mercury at the times of screening. Only one child had a blood-lead level above the federal Centers for Disease Control and Prevention's (CDC) recommended guideline of 10 µg/dl (CDC, 1991). For the mercury biomarker, again only one child had a urine-mercury level above the detection limit of the analysis and well below the level for health concern (ATSDR, 1992). Neither of these children resided near or had any reported contact with contamination from the PLW site.

The average blood-lead level in children living closer to the site was slightly higher than those living further away and average blood-lead levels had a greater increase over the study period for nearby residents, but the differences were not statistically significant. All of the individual blood-lead concentrations were well within a safe level as determined by the CDC. Additionally, the average blood-lead concentration measured in this screening was consistent with national cross-sectional data (Pirkle, 1994) which found geometric average blood-lead levels of 3.6 µg/dl for children under six years of age and 1.9 µg/dl for children six to nineteen years of age.

The biological concentrations of lead and mercury measured during the screening only reflect recent exposure to these two metals. The screening is unable to assess distant past exposures to this community. Consequently, although the current exposures appear to be low, children's past exposures could have been higher and of health significance.

Health indicator questions: Health indicator information, as reported by the parent, was collected by a questionnaire during the interview process. None of the self-reported responses were verified by interview of a diagnosing physician. The health indicator information indicated that children

residing closer to the site had a significantly greater likelihood of being diagnosed with learning disorders and aggressiveness. Although not significantly elevated, children living closer to the site had at least a two-fold increase in parent-reported diagnoses of attention deficient disorder, hyperactivity, and behavioral problems. There were no differences reported in any of the other health conditions asked in the questionnaire. The reason for the elevation in some of the health indicators for children residing closer to the site is not known. It might reflect past high exposure to lead that could not be identified during the testing. Alternately, parents that have a child with learning problems might have been more motivated to participate (response bias) if they lived closer to PLW and believed that the PLW was responsible for the child's problems. Reporting bias, selective suppression or revealing of the health indicator information, could also have been responsible for the differences detected. Since the answers were not clinically confirmed, the elevated rate could be due to differential reporting by residential location.

In summary: The Pompton Lakes screening project did not find evidence of unusual current exposure to lead or mercury in the children tested. Consequently, the Pompton Lakes Works does not currently appear to be an imminent hazard to children in the community. Although this exposure screening did not detect elevated lead or mercury body burdens in the surveyed population, these results should not be construed to mean that potential exposure (past, present, and/or future) is nonexistent. As stated in the 1994 Health Assessment for the Pompton Lakes Works, "this site represents a public health hazard due to past, and possibly future, completed exposure pathways." Consequently, continued remediation of both on- and off-site contamination should proceed to ensure no future potential impact to the community.

RECOMMENDATIONS

As an adjunct to biological screening, this study solicited information from parents on 12 physician diagnosed health conditions. Nine of the odds ratios for these health indicators were elevated for children living closest to the contaminated areas, two of the conditions (learning disorders and aggressiveness) significantly higher. Although the exposure screening was not designed to be a health effects study, information was solicited on these pertinent health conditions in order to provide guidance for future health activities.

While parental motivation or differential reporting may explain the higher prevalence of health conditions in the exposed neighborhood, these results could also represent effects of past lead exposure in the community. Distant past exposure to lead could not be evaluated in this screening. As noted above, the 1994 ATSDR Health Assessment provides substantial documentation of on- and off-site contamination and the potential for exposure in the community. Given the results of the health indicator questions and potential for past exposure, a medical records review should be considered in order to validate these results.

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TABLES

Table 1.—Potential Lead and Mercury Exposure Risk Factors by Residential Distance from Pompton Lakes Works (PLW).

Potential Exposure Factor	Lives Near PLW	Factor Present Yes	Factor Present No	Odds Ratio	95% Confidence Interval
Plays near PLW or Acid Brook:	Yes	47	34	5.38	2.94, 9.86
	No	28	109		
Lives in or visits home that has had soil remediation:	Yes	40	41	11.18	5.25, 23.77
	No	11	126		
Recent home remodeling:	Yes	29	52	1.51	0.84, 2.72
	No	37	100		
Lives in home built before 1960:	Yes	59	53	1.03	0.64, 1.65
	No	93	86		
Regularly visits homes with chipping paint:	Yes	16	62	1.87	0.88, 4.00
	No	16	116		
House pet that goes in & out of house:	Yes	42	39	0.92	0.53, 1.59
	No	74	63		
History of eating dirt & non-food items:	Yes	8	73	1.39	0.53, 3.68
	No	10	127		
Take food/bottle outdoors:	Yes	54	27	1.97	1.11, 3.49
	No	69	68		
Recently eaten garden vegetables:	Yes	5	76	0.39	0.14, 1.07
	No	20	117		
Recently eaten Fish:	Yes	51	30	0.86	0.48, 1.53
	No	91	46		
Household member work with heavy metals:	Yes	14	67	1.58	0.73, 3.44
	No	16	121		
Household member work in dental office:	Yes	6	75	3.57	0.87, 14.70
	No	3	134		
Home exposure to mercury:	Yes	3	77	0.50	0.13, 1.85
	No	10	127		
Any silver tooth fillings:	Yes	22	59	1.45	0.76, 2.76
	No	28	109		
Prescription medication:	Yes	9	72	1.59	0.62, 4.09
	No	10	127		

Table 2.—Average Concentration of Blood-Lead by Age Group.

Test and Screening Period	Age Group	Number Tests	Average Level	Standard Error	P-value
Blood-Lead					
1. June 1994	1- 5	43	3.01	0.25	
	6-10	81	2.35	0.12	0.017
	11-15	61	2.19	0.22	0.014
	16+	16	1.57	0.20	0.001
2. August 1994	1- 5	23	3.39	0.36	
	6-10	53	3.02	0.20	0.341
	11-15	45	2.52	0.16	0.034
	16+	13	2.63	0.53	0.230
3. Change (Aug-June)	1- 5	23	0.24	0.25	
	6-10	49	0.62	0.18	0.232
	11-15	43	0.58	0.20	0.300
	16+	13	1.01	0.50	0.134
Erythrocyte Protoporphyrin					
1. June 1994	1- 5	43	15.53	0.89	
	6-10	81	13.47	0.36	0.036
	11-15	61	16.57	0.70	0.355
	16+	16	16.31	1.32	0.644
2. August 1994	1- 5	23	14.74	1.26	
	6-10	53	13.40	0.73	0.334
	11-15	45	17.53	1.23	0.155
	16+	13	15.77	1.43	0.608
3. Change (Aug-June)	1- 5	23	-1.22	1.54	
	6-10	49	-0.12	0.58	0.420
	11-15	43	1.60	1.33	0.192
	16+	13	0.31	1.04	0.493

Table 3.—Average Concentration of Blood-Lead and Erythrocyte Protoporphyrin by Screening Period and Residential Distance from Pompton Lakes Works (PLW).

Test and Screening Period	Lives Near PLW	Number Tests	Average Level	Standard Error	P-value
Blood-Lead					
1. June 1994	Yes	79	2.46	0.15	0.548
	No	122	2.33	0.13	
2. August 1994	Yes	59	3.11	0.20	0.095
	No	75	2.69	0.16	
3. Change (Aug-June)	Yes	58	0.79	0.17	0.106
	No	70	0.41	0.16	
Erythrocyte Protoporphyrin					
1. June 1994	Yes	79	14.63	0.49	0.302
	No	122	15.37	0.48	
2. August 1994	Yes	59	15.39	0.75	0.827
	No	75	15.13	0.86	
3. Change (Aug-June)	Yes	58	0.88	0.66	0.370
	No	70	-0.17	0.91	

Table 4.—Average Concentration of Blood-Lead and Erythrocyte Protoporphyrin by Screening Period and Play Activity near the Pompton Lakes Works (PLW).

Test and Screening Period	Plays Near PLW	Number Tests	Average Level	Standard Error	P-value
Blood-Lead					
1. June 1994	Yes	72	2.26	0.16	0.385
	No	129	2.45	0.13	
2. August 1994	Yes	58	2.98	0.19	0.479
	No	76	2.80	0.17	
3. Change (Aug-June)	Yes	56	0.67	0.17	0.521
	No	72	0.51	0.16	
Erythrocyte Protoporphyrin					
1. June 1994	Yes	72	15.17	0.47	0.852
	No	129	15.03	0.48	
2. August 1994	Yes	58	15.67	0.75	0.523
	No	76	14.92	0.85	
3. Change (Aug-June)	Yes	56	1.09	0.64	0.235
	No	72	-0.31	0.91	

Table 5.—Average Concentration of Blood-Lead and Erythrocyte Protoporphyrin by Screening Period and Eating Locally Grown Vegetables from Gardens.

Test and Screening Period	Eats Food from Local Gardens	Number Tests	Average Level	Standard Error	P-value
Blood-Lead					
1. June 1994	Yes	23	2.43	0.34	0.870
	No	178	2.37	0.11	
2. August 1994	Yes	12	2.69	0.46	0.646
	No	122	2.90	0.13	
3. Change (Aug-June)	Yes	12	0.61	0.33	0.938
	No	116	0.58	0.13	
Erythrocyte Protoporphyrin					
1. June 1994	Yes	23	15.87	1039	0.415
	No	178	14.98	0.35	
2. August 1994	Yes	12	19.50	3.90	0.259
	No	122	14.83	0.50	
3. Change (Aug-June)	Yes	12	1.67	4.16	0.453
	No	116	0.16	0.49	

Table 6.—Multiple Regression Analysis: Summary of Living near the PLW and Playing near the PLW only.

Dependent Variable and Screening Period	Coefficient	Standard Error	P-value
1. June 1994 Blood-Lead			
Lives near the PLW	-0.29	1.02	0.773
Plays near the PLW	-0.19	0.24	0.435
2. August 1994 Blood-Lead			
Lives near the PLW	0.95	1.07	0.377
Plays near the PLW	0.16	0.32	0.622
3. Change in Blood-Lead Over Time			
Lives near the PLW	1.23	1.02	0.227
Plays near the PLW	-0.21	0.32	0.948
4. June 1994 Erythrocyte Protoporphyrin			
Lives near the PLW	-2.41	3.54	0.497
Plays near the PLW	0.54	0.85	0.525
5. August 1994 Erythrocyte Protoporphyrin			
Lives near the PLW	-6.96	4.94	0.161
Plays near the PLW	-1.14	1.48	0.443
6. Change in Erythrocyte Protoporphyrin Over Time			
Lives near the PLW	-4.06	4.88	0.407
Plays near the PLW	-1.14	1.52	0.453

Note: Other variables controlled for in the analysis include child's age and sex, age of residence, recent home remodeling, potential for exposure to paint chips, and potential for exposure to heavy metals.

Table 7.—Health Outcome Information by Residential Distance from Pompton Lakes Works (PLW).

Health Indicator	Lives Near PLW	Indicator Present: Yes	Indicator Present: No	Odds Ratio	95% Confidence Interval
Did not achieve developmental milestones:	Yes	7	73	1.21	0.30, 2.27
	No	10	126		
Diagnosed attention deficit disorder:	Yes	11	69	2.57	0.99, 6.69
	No	8	129		
Diagnosed hyperactive:	Yes	9	72	2.71	0.93, 7.92
	No	6	130		
Diagnosed learning disorders:	Yes	16	65	3.08	1.32, 7.16
	No	10	125		
Diagnosed behavioral problems:	Yes	8	73	2.02	0.70, 5.80
	No	7	129		
Diagnosed aggressive:	Yes	8	73	3.62	1.05, 12.42
	No	4	132		
Diagnosed kidney disorders:	Yes	0	81	-	-
	No	3	134		
Diagnosed hearing disorders:	Yes	8	73	1.14	0.45, 2.92
	No	12	125		
Diagnosed other neurological problems:	Yes	2	79	0.55	0.11, 2.81
	No	6	131		
Diagnosed small for child's age:	Yes	10	71	1.15	0.49, 2.69
	No	15	122		
Ever had undiagnosed rashes:	Yes	12	68	1.34	0.60, 2.99
	No	16	121		
Diagnosed anemic:	Yes	8	71	0.99	0.40, 2.48
	No	14	123		

FIGURE

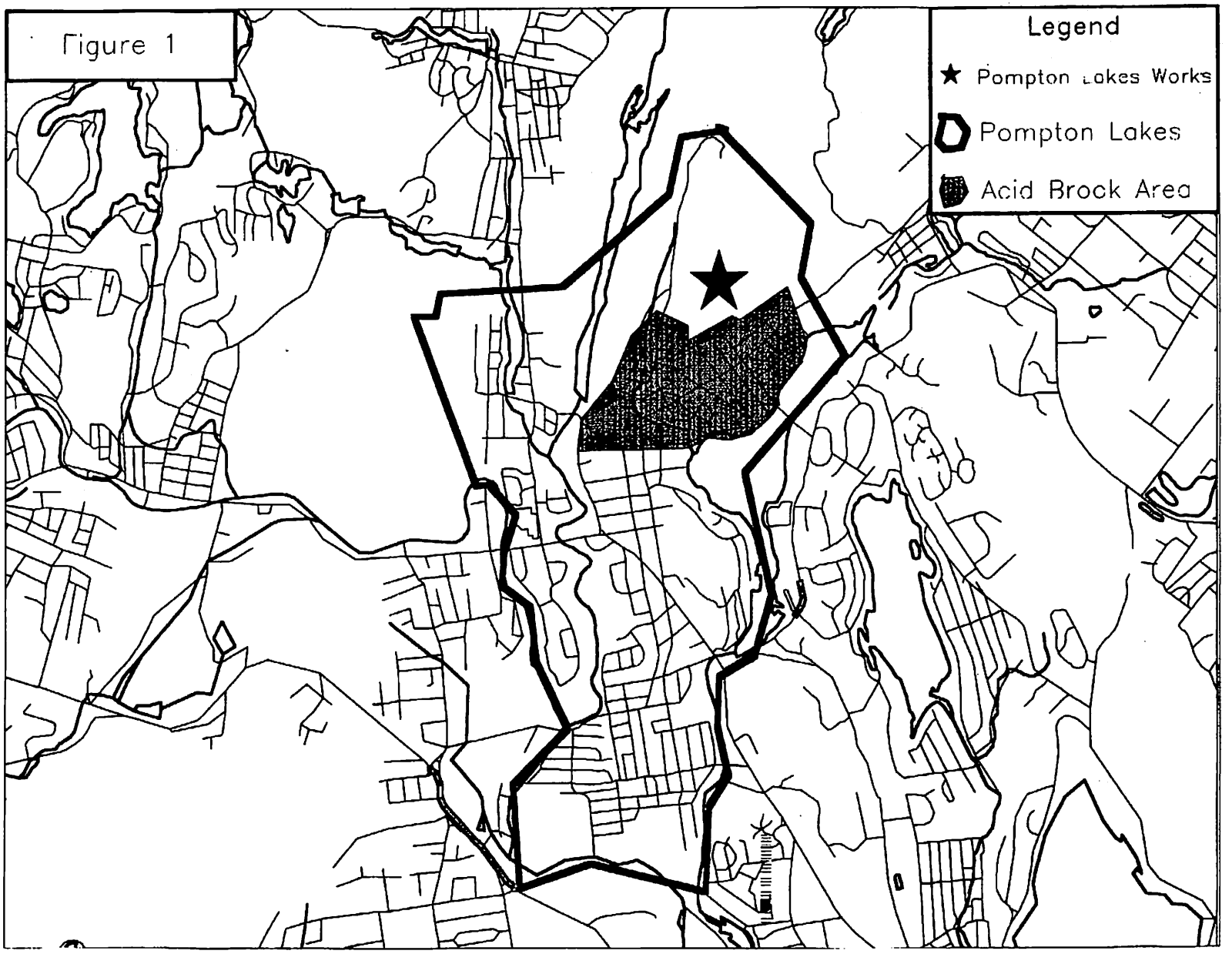
Figure 1
Legend
Pompton Lakes Works
Pompton Lakes
Acid Brock Area

APPENDIX.—POMPTON LAKES QUESTIONNAIRE.

Household ID: _ _ _ _
Individual ID: _ _ _ _
Interviewer ID: _ _

Date of interview: ___/___/19___

1. What is the actual address of your household?
   Street_____ Apt.____
   City_____ State ___ Zip code _____

2. What is the mailing address (if different)?
   Street_____ Apt.____
   City_____ State ___ Zip code _____

3. Age of your house? _ _ _ years

4. What is the telephone number of your household?
   (_ _) _ _ _ - _ _ _ _

5. What is your daytime phone number (if different)?
   (_ _) _ _ _ - _ _ _ _

6. This form is being answered by:
   1 - Mother of child
   2 - Father of child
   3 - Somebody else (relationship:_____)

7. What is your child's name?_____
   _____

8. Sex of child: 1 = Male 2 = Female

9. Date of child's birth: ___/___/19___

10. His/her age is: ___ years

11. How long has your child been living at this address?

1 = Less than 1 month
2 = 1 month or more but less than 2 months
3 = 2 to 3 months
4 = 3 to 6 months
5 = 6 months to 1 year
6 = 1 to 5 years
7 = More than 5 years
8 = Don't know

12. Please list any previous addresses since child's birth:

12a. Street_____ Apt._____
City_____ State___ Zip code_____

12b. How long has your child been living at this address?

1 = Less than 1 month
2 = 1 month or more but less than 2 months
3 = 2 to 3 months
4 = 3 to 6 months
5 = 6 months to 1 year
6 = 1 to 5 years
7 = More than 5 years
8 = Don't know

12c. Street_____ Apt._____
City_____ State___ Zip code_____

12d. How long has your child been living at this address?

1 = Less than 1 month
2 = 1 month or more but less than 2 months
3 = 2 to 3 months
4 = 3 to 6 months
5 = 6 months to 1 year
6 = 1 to 5 years
7 = More than 5 years
8 = Don't know

The next three questions are for your present address.

13. Has there been any removal and replacement of soil around your residence:

1 = Yes
2 = No **(Go to 14)**
3 = Don't know **(Go to 14)**

13a. If yes, when did it take place?
Start ___/___ (month/year)
Finish ___/___ (month/year)
Don't know

13b. Did you continue normal activities at your residence?
1 = Yes
2 = No
3 = Don't know

14. Has there been any removal and replacement of the soil of properties adjacent to your residence?
1 = Yes
2 = No **(Go to 15)**
3 = Don't know **(Go to 15)**

14a. If yes, when did it first take place?
Start ___/___ (month/year)
Finish ___/___ (month/year)
Don't know

14b. Did you continue normal activities at your residence?
1 = Yes
2 = No
3 = Don't know

14c. If there was a second property?
Start ___/___ (month/year)
Finish ___/___ (month/year)
Don't know

14d. Did you continue normal activities at you residence?
1 = Yes
2 = No
3 = Don't know

14e. If there was a third property?
Start ___/___ (month/year)
Finish ___/___ (month/year)
Don't know

14f. Did you continue normal activities at you residence?
1 = Yes
2 = No
3 = Don't know

15. Has there been any removal and replacement of soil of any property your child regularly visits?

1 = Yes
2 = No **(Go to 16)**
3 = Don't know **(Go to 16)**

15a. If yes, did you child continue to visit during the removal?

1 = Yes
2 = No
3 = Don't know

16. Was there any removal and replacement of soil in any of your child's previous residences?

1 = Yes
2 = No **(Go to 17)**
3 = Don't know **(Go to 17)**

16a. If yes, which residence?

1 = 12 A
2 = 12 C
3 = other
4 = don't know

17. What is the name of your child's doctor?

_____

18. Doctor's telephone number and address: (____) ____-_____
Street _____ Apt._____
City _____ State____ Zip code_____

19. Has there been any recent (within the last 2 months) remodelling, repair or painting done in your home (especially window frame replacement)?

1 = Yes
2 = No
3 = Don't know

20. Does any member of your household work in a dental office?

1 = Yes
2 = No
3 = Don't know

21. Does any member of your household work in a job with exposure to heavy metals? Examples of these are lead, cadmium, nickel, silver or gold.

1 = Yes
2 = No
3 = Don't know

22. Does any member of your household do any work at home that involves the use of mercury (thermometer or barometer making)?
    1 = Yes
    2 = No
    3 = Don't know

23. Where do you get your drinking water? _____

24. Do you use private well water for any home water use?
    1 = Yes
    2 = No
    3 = Don't know

25. Do you have any pets?
    1 = Yes
    2 = No **(GO TO 27)**
    3 = Don't know

26. If Yes, do your dog or cat ever come inside the house?
    1 = Yes
    2 = No
    3 = Don't know

27. Has your child had any known exposure to mercury in your home, such as a broken thermometer or barometer?
    1 = Yes
    2 = No
    3 = Don't know

28. Does your child live in or regularly visit a house with peeling or chipping paint build before 1960 (this could include the home of a babysitter or relative)?
    1 = Yes
    2 = No
    3 = Don't know

29. Does your child spend any time in the areas around the DuPont Pompton Lakes Works or the Acid Brook section of Pompton Lakes?
    1 = Yes
    2 = No
    3 = Don't know

30. Has your child eaten vegetables grown in a local garden within the last two months?
    1 = Yes
    2 = No
    3 = Don't know

31. Has your child eaten any fresh, frozen or canned seafood within the last two months?
    1 = Yes
    2 = No
    3 = Don't know

32. Does your child often take food or a bottle (baby bottle) outside to play?
    1 = Yes
    2 = No
    3 = Don't know

33. Has your child ever been tested for Lead?
    1 = Yes
    2 = No **(GO TO 35)**
    3 = Don't know

34. If Yes: a. When: ___/___/19___
    b. What were the results:_____

35. Has your child ever been tested for Mercury?
    1 = Yes
    2 = No **(GO TO 37)**
    3 = Don't know

36. If Yes: a. When: ___/___/19___
    b. What were the results: _____

37. Does your child have a history of eating dirt, paint chips, or other non-food items?
    1 = Yes
    2 = No
    3 = Don't know

38. During routine pediatric checkups, did your child achieve developmental milestones?
    1 = Yes
    2 = No
    3 = Don't know

39. Has your child ever been diagnosed as having attention deficit disorder?
    1 = Yes
    2 = No
    3 = Don't know

40. Has your child ever been diagnosed as having hyperactivity?
    1 = Yes
    2 = No
    3 = Don't know

41. Has your child ever been diagnosed as having learning disorders?
    1 = Yes
    2 = No
    3 = Don't know

42. Has your child ever been diagnosed as having behavioral problems?
    1 = Yes
    2 = No
    3 = Don't know

43. Has your child ever been diagnosed as having aggressiveness?
    1 = Yes
    2 = No
    3 = Don't know

44. Has your child ever been diagnosed as having kidney disorders?
    1 = Yes
    2 = No
    3 = Don't know

45. Has your child ever been diagnosed as having hearing disorders?
    1 = Yes
    2 = No
    3 = Don't know

46. Has your child ever been diagnosed as having any other neurological problems?
    1 = Yes
    2 = No
    3 = Don't know

47. Is your child small for his/her age (as determined by the pediatrician or primary care physician)?
    1 = Yes
    2 = No
    3 = Don't know

48. Has your child ever had undiagnosed rashes?
    1 = Yes
    2 = No
    3 = Don't know

49. Has your child ever been diagnosed as being anemic or deficient in iron?
    1 = Yes
    2 = No
    3 = Don't know

50. Has your child taken any prescription medications in the last 2 months to treat a skin disorder or infection (e.g.,psoriasis, impetigo, pinworm, crab louse)?
    1 = Yes
    2 = No **(GO TO 51)**
    3 = Don't know

51. If yes, please give name of medication(s):_____
    _____

52. Has your child have a silver tooth filling?
    1 = Yes
    2 = No
    3 = Don't know

This is the end of the interview. Thank you for your cooperation.