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EFFECT OF IN-HOME EDUCATIONAL INTERVENTION ON CHILDREN'S BLOOD LEAD LEVELS IN MILWAUKEE

TECHNICAL REPORT

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DISCLAIMER

CONTRIBUTING ORGANIZATIONS

The study described in this report was conducted by the U.S. Environmental Protection Agency (EPA) and its contractor QuanTech and the Milwaukee Health Department. The Milwaukee Health Department provided the data and EPA and its contractor entered the data into a database, analyzed the data, and produced the report.

QuanTech

Quantech (formerly David C. Cox & Associates) provided technical assistance regarding the data management, and was responsible for the statistical analysis, and for the overall production of the report.

U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (EPA) funded the analysis of the data and was responsible for managing the study, for reviewing study documents, and for arranging for the peer review of the final report. The EPA Project Leader was Bradley Schultz. The EPA Work Assignment Manager and Project Officer was Samuel Brown. Cindy Stroup and Barbara Leczynski provided valuable assistance. Janet Remmers, Dan Reinhart, Phil Robinson, and Ben Lim also provided useful comments.

Milwaukee Health Department

The study could not have been done without the assistance and cooperation of the Milwaukee Health Department. Major contributors included Amy Murphy, Mary Jo Gerlach, Kris White, and Sue Shepeard.

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EXECUTIVE SUMMARY

BACKGROUND

Education and counseling are relatively inexpensive components of some programs for reducing blood lead levels in children. However, these measures have not been conclusively demonstrated to be effective. The purpose of this study was to determine whether blood lead levels declined after in-home educational visits. The interventions were conducted from 1991 to 1993 by regular Milwaukee Health Department staff who went to homes of children with elevated (20-24 µg/dl) blood lead levels. The in-home educational visits described hazards associated with childhood lead exposure, and potential sources of the hazards in the home were identified. The importance of the child's personal hygiene, the child's nutrition, and overall dust reduction and cleaning practices was also discussed. The visits lasted about one hour and were performed by health department paraprofessionals. The in-home educational visits are part of a program designed to reduce children's lead exposure in Milwaukee where widespread blood lead testing identifies children with elevated blood lead levels. Outreach workers and/or other public health officials currently attempt to contact each family with children having elevated blood lead levels.

METHODS

Data was compiled retrospectively from the Milwaukee Health Department records of blood lead measurements collected through the blood lead testing program. The analysis was based on a comparison of changes in blood lead levels for a study group of children who received the outreach educational interventions versus a reference group of children who did not receive the educational interventions. Children who moved or whose blood lead levels may have been affected by a lead paint abatement were eliminated from the study. The study group includes all other children who received outreach interventions between 1991 and 1993, had at least one blood lead measurement between 20-24 µg/dl before the intervention, and at least one measurement after the intervention. Similarly, the reference group includes children who from 1990 to early 1994 had at least one measurement between 20-24 µg/dl and a followup measurement. Comparisons of the children whose families received an educational visit with a reference group was important, because changes in average blood lead level measurements may be caused by phenomena unrelated to educational intervention.

RESULTS

Average blood lead levels, adjusted for seasonality and age of the children in the Milwaukee outreach intervention program, were about 21% lower after intervention than before intervention. Blood lead levels in the reference group of non-recipients of outreach visits also declined, but by about 6%. This difference was statistically significant at a p-value less than 0.001. The difference in the average declines in blood lead levels yielded an estimate of the net effectiveness of outreach educational intervention of 21% - 6% = 15% (with a 95% confidence interval of 8% to 23%). Effectiveness of the educational intervention did not depend significantly on a child's age or sex.

DISCUSSION

The retrospective comparison shows that in-home educational visits may have resulted in reducing children's blood lead levels by about 15% more than for a reference group without interventions. The validity of this conclusion depends upon whether children who received the visits were comparable to reference group children whose families were often unavailable for outreach visits. Families that were unavailable for outreach visits may have been more likely to exhibit behavior patterns responsible for the continued elevation of their children's blood lead levels. Nevertheless, an examination of available data on blood lead levels and demographics indicated that the study and reference groups were similar and were comparable for the purposes of determining the beneficial effects of the outreach educational program. Educational efforts at doctor's offices and clinics may also have contributed to reduced blood lead levels in both groups, thus having little effect on the net reduction.

Total costs of the outreach educational visits were estimated to be in the range of $100 per visit. Blood lead levels of the children studied were usually still elevated after the educational intervention alone. However, important declines were observed. Educational intervention appears to be a useful and inexpensive component of lead exposure reduction programs.

1 DESCRIPTION OF STUDY

1.1 OBJECTIVE

Changes in blood lead levels (PbB) following outreach interventions were investigated using data available from the Milwaukee Health Department on PbB levels through July, 1994. Outreach involves educational visits by Milwaukee Health Department staff to the homes of children with elevated blood lead levels, usually in the 20-24 µg/dl range. The purpose of the analysis was to determine whether blood lead levels declined after these educational interventions, calculate the magnitude of the change, and identify factors related to any change.

1.2 BACKGROUND

There have been previous indications that education and counseling may be effective components of programs for reducing blood lead levels in children. The main focus of counseling efforts would be to encourage housecleaning, improve personal hygiene and diet, and discourage hand-to-mouth behavior. An early study (Charney, et, al, 1983) demonstrated that periodic wet mopping of rooms to remove dust lead can result in declines in blood lead levels. However, no study conclusively showed that educational efforts have been effective (see USEPA, 1995). A study that specifically addressed the issue of the effectiveness of education was based on data from children living near a lead smelter in Granite City, Illinois in 1991 (Kimbrough, et, al). After education and counseling of households with children with slightly elevated blood lead levels, arithmetic mean blood lead levels decreased from 15.0 to 7.8 µg/dl. However, since there was no control group for comparison, the decreases in the blood lead levels could be at least partially attributed to other factors such as seasonality and age.

The data for this study of educational intervention effects is a result of a widespread blood lead testing program targeting all Milwaukee children between six months and seven years old. The program identifies children with elevated blood lead levels, so steps can be taken to reduce lead exposure and lead-related health impacts. Under the current program, families of all children are notified of the results and encouraged to obtain another measurement within a year. Measurements above 24 µg/dl trigger attempts to schedule visits by a public health nurse and/or an Environmental Health Inspector. If a measurement is from 20-24 µg/dl (and no previous measurement exceeds 24 µg/dl), attempts are made to arrange a visit by an outreach worker.

An outreach worker is a public health paraprofessional who received about one full week of training followed by an approximately eight-week apprenticeship. Outreach workers typically make only one visit to a family. During the visit, the outreach worker:

1) instructs the family on the significance of blood lead measurements;
2) verifies sources of medical care and encourages followup measurements;
3) teaches the family about the hazards of lead poisoning, its prevention and control;
4) teaches the family about identifying sources of lead in the home and other environments where the child spends significant time;
5) identifies siblings at risk for blood lead poisoning whose blood lead levels should also be tested;
6) surveys the immediate environment for sources of lead exposure;
7) demonstrates simple and appropriate clean-up measures for reducing obvious lead exposures (such as washing and rinsing window sills and taping cardboard over cracks in the wall);
8) makes note of obvious evidence of environmental lead hazards to be inspected by an Environmental Health Inspector if deemed appropriate; and
9) documents the outreach worker's activities.

From an informal analysis reproduced in Appendix C, total costs of the program have been estimated to result in average costs of about $100 per outreach visit.

Outreach interventions were phased in from 1991 through the first half of 1992. Outreach was intended as a supplement to an intervention program that already included visits from Public Health Nurses and Environmental Lead Inspectors to families of children with blood lead measurements exceeding 24 µg/dl. By the summer of 1992, outreach visits were attempted for all families with children with at least one measurement from 20-24 µg/dl and no previous measurement greater than 24 µg/dl.

The analysis of the Milwaukee Health Department data is based on a retrospective comparison of changes in pairs of blood lead levels for a study group of children who received the outreach educational interventions versus a reference group of children who did not receive the educational interventions. Children who moved or whose blood lead levels may have been affected by a lead paint abatement, a public health nurse visit, or a change of address were excluded from the study. The study group includes all other children who received outreach interventions between 1991 and 1993 and had at least one blood lead measurement between 20-24 µg/dl before the intervention and at least one measurement after the intervention. Similarly, the reference group includes children who from 1990 to early 1994 had at least one measurement between 20-24 µg/dl and a followup measurement.

A comparison between study and reference groups is important, because "regression to the means" and time-related trends unrelated to the intervention may result in decreases (or increases) in observed blood lead levels after intervention. "Regression to the means" is the phenomenon that first measurements are followed by second measurements which on average are closer to the mean. The phenomenon occurs because high blood lead measurements may be an indication of measurement error and short-term fluctuations, as well as actual high sustained blood lead levels. Measurements may tend to be lower after an intervention, regardless of whether the intervention is truly effective, because only children with elevated blood lead measurements receive interventions.

The validity of the comparison of blood lead levels between the study and reference groups depends on the assumption that the two groups of children were similar with respect to factors related to blood lead levels. Table 1 demonstrates the similarity of the age distributions for the two groups of children. Table 2 shows that the two groups of children were similar with respect to categories based on race and ethnicity. As Table 3 shows, children in the reference group were generally tested earlier than children who received outreach visits. Seventy of the reference group children had blood lead tests before the start of the outreach program. Families of many of the remaining 156 children in the reference group could not be contacted after three attempts. The main analysis used all 226 children in the reference group tested from 1990 to early 1994. A sensitivity analysis then tested to see how results would be affected if the reference group had been restricted to children with initial measurements after September, 1991. Differences between the reference group and the study group in: 1) the timing of the measurements and 2) behavioral characteristics (indicated by the apparent refusal of outreach visits to families of children in the reference group) must be taken into account to properly interpret the study's results. Nevertheless, the comparison between the study and reference groups in conjunction with the sensitivity analysis allowed for a relatively unbiased assessment of the effect of the outreach interventions.

1.3 DATA

Two sets of data of pairs of childrens' blood lead measurements were created for the analysis of outreach effectiveness, one for the "study" group and one for the "reference" group. Blood lead measurements were either based on capillary or venous blood samples. Venous measurements are thought to be more reliable, since they are based on larger blood samples, and are thus less sensitive to contamination. Also, fingers are probably more likely to be contaminated by lead dust. For this reason, the comparison between groups is considered separately for venous and capillary samples.

Families of children in both groups may have received educational information at their doctor's office or clinic where the blood sample was taken. Thus, the comparison between the study children and reference children is designed to measure the additional benefit attributable to the outreach visits. For both study and reference databases, an attempt was made to exclude pairs of measurements for children whose blood lead levels may have changed between measurements because of other events not directly related to the outreach intervention. In particular, measurements were excluded for children who moved between measurement dates, or if an abatement or a follow-up visit by a public health nurse occurred before the second measurement.

Table 1. Number of Children by Age Group[1].

AGE (years)	STUDY	REFERENCE
0.5 to 1.5	12 (6%)	25 (11%)
1.5 to 2.5	46 (25%)	56 (25%)
2.5 to 3.5	39 (21%)	50 (22%)
3.5 to 4.5	44 (24%)	47 (21%)
4.5 to 5.5	29 (16%)	32 (14%)
5.5 to 7.0	17 (9%)	16 (7%)
TOTAL	187	226

[1]Age at the time of the initial measurement.

Table 2. Number of Children by Race/Ethnicity in the Study and Reference groups.

RACE/ETHNICITY	STUDY	REFERENCE
AFRICAN-AMERICAN	128 (68%)	102 (45%)
ASIAN	4 (2%)	6 (3%)
NATIVE AMERICAN	1 (1%)	0 (0%)
WHITE HISPANIC	20 (11%)	18 (8%)
WHITE NON-HISPANIC	13 (7%)	10 (4%)
OTHER	2 (1%)	9 (4%)
UNKNOWN	19 (10%)	81 (36%)
TOTAL	187	226

The creation of data sets for both groups is described in greater detail in the next two sections and Appendix A.

1.3.1 <u>The Outreach Study Group</u>

Data for the study group includes the last pre-intervention and first post-intervention blood lead measurements from 187 out of 365 children identified as

Table 3. Number of Initial and Followup Measurements for the Study and Reference Groups by Time Period.

YEAR/QUARTER	STUDY		REFERENCE	
	PRE INTERVENTION	POST INTERVENTION	MEASUREMENT	
			INITIAL	FOLLOWUP
1990/1stQ			8	1
2ndQ			8	3
3rdQ			8	5
4thQ			7	1
1991/1stQ			12	4
2ndQ			8	8
3rdQ			19	10
4thQ	9		26	11
1992/1stQ	19	4	17	23
2ndQ	32	4	34	23
3rdQ	62	19	44	43
4thQ	21	25	19	30
1993/1stQ	17	41	13	33
2ndQ	18	42	2	23
3rdQ	7	29	1	8
4thQ	2	13		
1994/1stQ		8		
2ndQ		2		
TOTAL	187	187	226	226

receiving outreach visits between 1991 and 1993. Reasons for excluding the 365-187=178 children are as follows: 8 had pre-intervention measurements above 24 µg/dl, 10 had pre-intervention measurements that never exceeded 20 µg/dl, 29 moved, 25 had post-outreach intervention measurements but none before the outreach visit, 98 had pre-outreach intervention measurements but none after, and 8 were not between 6 months and 7 years old.

1.3.2 The Outreach Reference Group

Data for the reference group of 226 children includes pairs of consecutive measurements from children who did not receive outreach visits. A pair of measurements was eligible for the reference database if: 1) neither measurement occurred before a nursing intervention, or abatement; 2) the first of the two measurements was between 20-24 µg/dl; and 3) the first measurement was taken between 1990 and 1993, and 4) both measurements were taken while the child was between 6 months and 7 years old.

Each child's first two measurements (in chronological order) for the same address from the data set described in Appendix A were used to create the reference group database. 328 of the children had at least two measurements with the first measurement falling between 20 and 24 µg/dl and no intervention before the second measurement date. Eighteen cases with an abatement (removal of lead based paint) occurring between the measurement dates and 1 case with an invalid recorded date of measurement were excluded. In 236 of the remaining cases, both measurements were after December 31, 1989. Of these 236 cases, 226 children were between six months and seven years old at the time of both measurements.

1.3.3 Adjustment of Data for Age and Seasonality Effects

1990-93 blood lead level measurements collected by the Milwaukee Health Department from 13,746 children were shown in an analysis by Pawel, et al (1995) to depend on age and season. Results from the analysis were used to adjust the 1990-1994 blood lead levels in both the reference and study databases for seasonality and age effects. The adjustments were designed to produce "equivalent" PbB measurements that would have been obtained in January at age two years. The seasonality and age effect adjustments were based on data from the same location and a similar time period as the study and reference group data. Otherwise, the assessment of outreach intervention effects could have been seriously biased. Seasonality, for example, may differ substantially by location and time, because seasonality may depend on factors such as climate (see McCusker, 1979), age (Cooney, et al, 1989; Baghurst, et al, 1992), and race. For tables of the adjustment factors and additional details, see Pawel, et al, 1995.

1.4 PEER REVIEW

This study was reviewed independently by members of a peer review panel. Comments which are important for interpreting the study results or which had an important impact on the report are discussed below.

Many of the comments from the reviewers requested additional information on the characteristics of the study and reference groups. In response, descriptive information about the groups was added. Exclusion criteria had been used to define the groups in a way that the two groups would be comparable. Tables were added to the report to show that the study and reference group children were similar with respect to categories based on age, race and ethnicity. Some reviewers were concerned that much of the reference group data was collected before the start of the outreach program (October, 1991). The report now includes a sensitivity analysis which showed that excluding measurements before October, 1991 would not have substantially changed the results of the study. Section 2.2 was added to provide a detailed discussion of these and related issues.

A comment was made that the report did not present data showing that the outreach visits induced families to make changes in self-protective behavior. The changes in behavior would then have resulted in changes in blood lead levels. Unfortunately, since the outreach workers would typically make only one visit to a family, data on behavior changes was unavailable. However, the study did find an association between conducting the visits and declines in blood lead levels. Since the study and reference groups were comparable, changes in blood lead levels most likely would have been similar without the outreach interventions. The difference in the changes in blood lead levels most likely was due to the information imparted through the outreach interventions.

EPA has established a public record for the peer review under administrative record 151. The record is available in the TSCA Nonconfidential Information Center, which is open from noon to 4 PM Monday through Friday, except legal holidays. The TSCA Nonconfidential Information Center is located in Room NE-B607, Northeast Mall, 401 M Street SW, Washington, D.C.

2 SUMMARY OF ANALYSIS AND RESULTS

2.1 COMPARISONS BETWEEN THE STUDY AND REFERENCE GROUPS

Figure 1 illustrates greater decreases in adjusted blood lead levels for the 187 children who received outreach visits than for the 226 children in the reference group. As described later in this section, an analysis of variance confirmed that the declines in adjusted PbB values were significantly greater for the study than the reference group. Except when noted, the analysis is based upon the adjusted blood lead values.

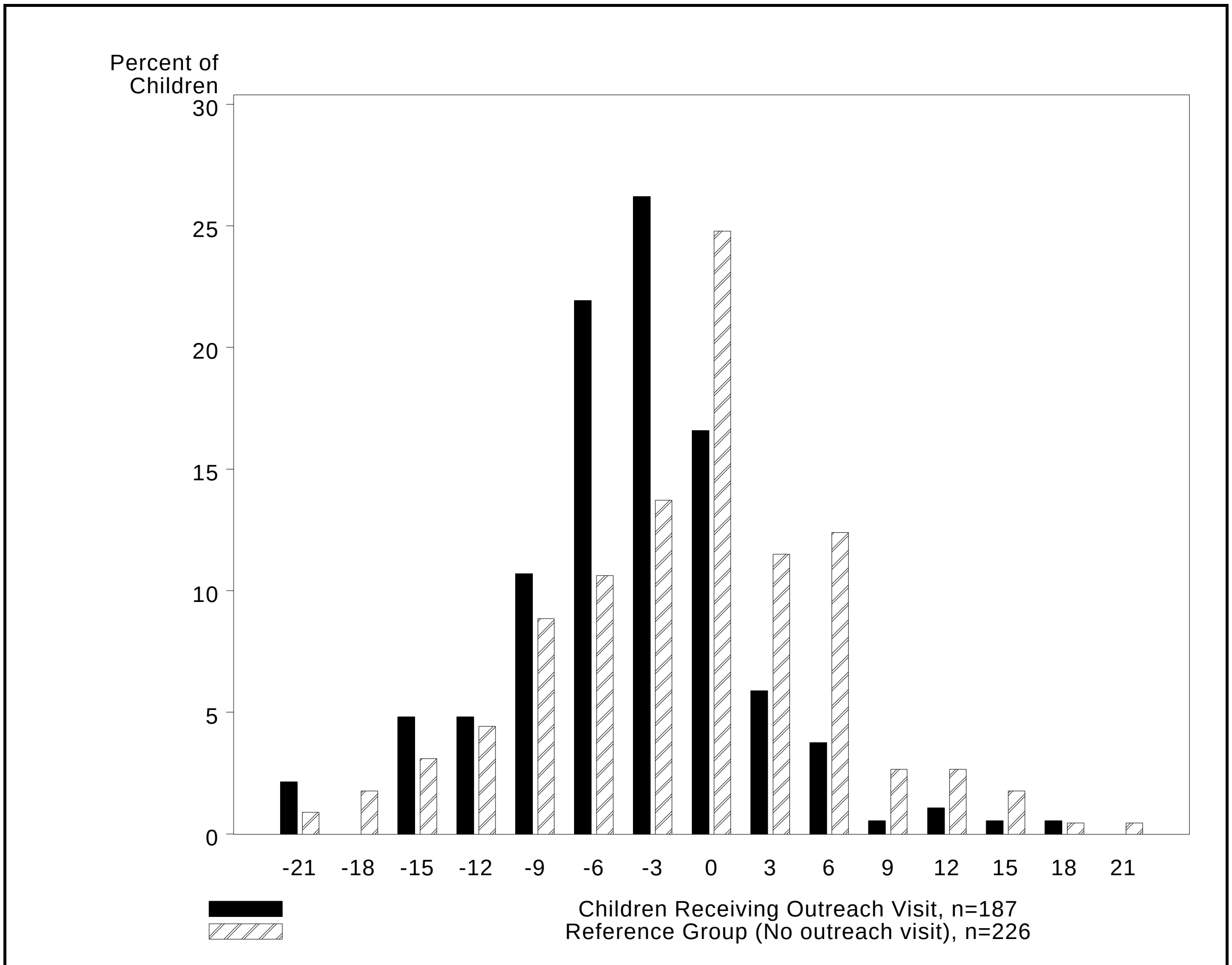

Figure 1. Frequency Distribution for Changes in Adjusted Blood Lead Levels (µg/dl) of Children in the Study of Outreach Intervention

Overall changes in mean blood lead values by measurement type and gender for both the study and reference groups are summarized in Table 4. Initial measurements are summarized in Table 5. Major results are summarized in Table 9. For children who received an outreach intervention, average post-intervention PbB measurements were 4.24 µg/dl, or about 21% less than pre-intervention measurements. The average pre-intervention measurement was about 20 µg/dl. The corresponding 95% confidence intervals for declines in PbB levels are 3.3 µg/dl to 5.2 µg/dl and 16% to 26%. For the reference group, the second measurement was on average 1.18 µg/dl or about 6% less than the first measurement. The corresponding 95% confidence intervals for children who did not receive an outreach intervention are 0.2 µg/dl to 2.2 µg/dl and 1% to 10%. The estimated decrease in PbB attributable to outreach intervention is 3.06 µg/dl = 4.24 µg/dl - 1.18 µg/dl or about a 15% decline from pre-intervention levels. The corresponding 95% confidence intervals are 1.6 µg/dl to 4.5 µg/dl and 8% to 23%.

An analysis of unadjusted data would have yielded essentially identical results. Summary statistics for the unadjusted data are shown in Tables 6 and 7. The average decrease in the unadjusted means was 4.12 µg/dl for the study group and 1.24 µg/dl for the reference group. The estimated decrease in PbB attributable to outreach intervention would have been 2.88 µg/dl = 4.12 µg/dl - 1.24 µg/dl, which represents about a 14% decline from pre-intervention levels. The corresponding 95% confidence intervals would have been 1.5 µg/dl to 4.3 µg/dl and 7% to 20%.

The four measurement type codes indicate the method of measurement, capillary or venous, for the pairs of PbB measurements. Except for the Venous-Capillary permutation (with only a total of 20 measurements), average net differences between decreases in (adjusted) PbB for the reference and study groups were very consistent, between 2.88 µg/dl and 3.65 µg/dl. For both the reference and study groups, declines in PbB were not statistically significantly different between males and females.

Results from the analyses of variance (ANOVA) in Table 8 showed that declines in PbB were significantly greater for the study group than for the reference group ($p<.001$); differences in the declines did not differ significantly by sex or measurement type. Frequency distributions for changes between measurements in PbB are shown separately for males and females in Figures 2 and 3.

The last two rows of Tables 4 and 5 indicate how the results would have changed if the reference group had been restricted to children with initial measurements after September, 1991. The estimated decrease attributable to the educational intervention would have been somewhat larger, 3.95 µg/dl, since the average change in PbB for children in the "restricted" reference group was only about -0.3µg/dl. Nevertheless, the ANOVA results would have been essentially unchanged. Declines in PbB would still not have differed significantly by sex or blood lead measurement type.

The relationship between changes in PbB and the time between measurements was also examined. The downward sloping regression lines shown in Figures 4 and 5 suggest slightly larger decreases in PbB values between measurements when the time

Table 4. Summary Statistics for Changes in Adjusted Blood Lead Levels (µg/dl) for the Study Group and Reference Group by Measurement Type and Gender.

GROUP	STATISTIC	MEASUREMENT TYPE[1]					GENDER			OVERALL
		CC	CV	VV	VC	MISSING	MALE	FEMALE	MISSING	
STUDY	Mean S. Deviation Sample Size	**-5.06** 5.33 (37)	**-4.73** 5.38 (29)	**-3.86** 6.11 (65)	**-4.59** 10.17 (10)	**-3.72** 6.88 (46)	**-3.71** 5.80 (107)	**-4.97** 6.89 (79)	**-2.37** (1)	**-4.24** 6.28 (187)
REFERENCE[2]	Mean S. Deviation Sample Size	**-1.58** 6.63 (49)	**-1.08** 7.40 (21)	**-0.98** 6.39 (71)	**1.88** 6.79 (10)	**-1.55** 8.03 (75)	**0.37** 6.54 (123)	**-2.78** 7.28 (90)	**-4.75** 7.78 (13)	**-1.18** 7.11 (226)
NET[2]	Mean S. Error	**-3.48** 1.29	**-3.65** 1.90	**-2.88** 1.07	**-6.47** 3.87	**-2.17** 1.37	**-4.08** 0.81	**-2.19** 1.09	**2.38** 8.07	**-3.06** 0.66
REFERENCE From 10/91[3]	Mean S. Deviation Sample Size	**-1.13** 6.78 (34)	**-1.69** 7.79 (18)	**-1.69** 6.70 (54)	**2.97** 6.20 (9)	**2.15** 6.32 (41)	**0.69** 6.81 (95)	**-1.81** 6.76 (61)	**N/A** (0)	**-0.29** 6.88 (156)
NET[3]	Mean S. Error	**-3.94** 1.46	**-3.04** 2.09	**-2.17** 1.19	**-7.56** 3.82	**-5.87** 1.42	**-4.40** 0.90	**-3.16** 1.16	**N/A**	**-3.95** 0.72

[1]CC = Both measurements are capillary; CV = First is capillary, second is venous;
VC = First is venous, second is capillary; VV = Both are venous.
MISSING = Type of at least one measurement is unknown.
[2]Reference group includes 226 children; Net = Difference between study and reference group.
[3]Excludes reference group measurements before 10/91.

Table 5. Summary Statistics for Adjusted Initial Mean Blood Lead Levels (µg/dl) for the Study Group and Reference Group by Measurement Type and Gender.

GROUP	STATISTIC	MEASUREMENT TYPE[1]					GENDER			OVERALL
		CC	CV	VV	VC	MISSING	MALE	FEMALE	MISSING	
STUDY	Mean	**19.2**	**19.6**	**20.2**	**19.5**	**20.8**	**19.8**	**20.3**	**22.8**	**20.0**
	S. Deviation	3.33	3.19	2.97	7.14	4.90	3.78	4.12		3.92
	Sample Size	(37)	(29)	(65)	(10)	(46)	(107)	(79)	(1)	(187)
REFERENCE	Mean	**21.3**	**21.2**	**21.0**	**22.7**	**21.0**	**21.3**	**20.8**	**22.6**	**21.2**
	S. Deviation	3.89	3.66	3.24	3.94	3.78	3.52	3.38	5.67	3.63
	Sample Size	(49)	(21)	(71)	(10)	(75)	(123)	(90)	(13)	(226)
REFERENCE From 10/91[2]	Mean	**21.7**	**21.3**	**21.9**	**22.7**	**20.8**	**21.7**	**21.2**	**N/A**	**21.5**
	S. Deviation	3.16	3.93	2.93	4.17	2.99	3.37	2.90		3.20
	Sample Size	(34)	(18)	(54)	(9)	(41)	(95)	(61)	(0)	(156)

[1]CC = Both measurements are capillary; CV = First is capillary, second is venous;
VC = First is venous, second is capillary; VV = Both are venous.
MISSING = Type of one or both of the measurements unknown.
[2]Excludes reference group measurements before 10/91.

Table 6. Summary Statistics for Changes in Unadjusted Blood Lead Levels (µg/dl) for the Study and Reference Group by Measurement Type and Gender.

GROUP	STATISTIC	MEASUREMENT TYPE[1]					GENDER			OVERALL
		CC	CV	VV	VC	MISSING	MALE	FEMALE	MISSING	
STUDY	Mean S. Deviation Sample Size	**-4.51** 5.06 (37)	**-5.28** 5.74 (29)	**-3.82** 5.82 (65)	**-2.70** 10.85 (10)	**-3.80** 6.17 (46)	**-4.07** 5.95 (107)	**-4.16** 6.31 (79)	**-5.00** (1)	**-4.12** 6.07 (187)
REFERENCE[2]	Mean S. Deviation Sample Size	**-1.41** 7.95 (49)	**-1.38** 7.27 (21)	**-1.48** 6.39 (71)	**2.10** 9.88 (10)	**-1.32** 7.01 (75)	**0.04** 6.82 (123)	**-2.92** 7.28 (90)	**-1.77** 6.36 (13)	**-1.24** 7.10 (226)
NET	Mean S. Error	**-3.10** 1.41	**-3.90** 1.91	**-2.34** 1.03	**-4.80** 4.64	**-2.48** 1.22	**-4.11** 0.84	**-1.24** 1.05	**-3.23** 6.60	**-2.88** 0.65
REFERENCE From 10/91[3]	Mean S. Deviation Sample Size	**-0.71** 7.45 (34)	**-1.39** 7.50 (18)	**-1.22** 6.28 (54)	**2.78** 10.23 (9)	**1.24** 6.00 (41)	**0.84** 6.88 (95)	**-1.95** 6.67 (61)	**N/A** (0)	**-0.25** 6.91 (156)
NET	Mean S. Error	**-3.80** 1.52	**-3.89** 2.06	**-2.60** 1.12	**-5.48** 4.84	**-5.04** 1.31	**-4.91** 0.91	**-2.21** 1.11	**N/A**	**-3.87** 0.71

[1]CC = Both measurements are capillary; CV = First is capillary, second is venous;
VC = First is venous, second is capillary; VV = Both are venous.
MISSING = Type of at least one measurement is unknown.
[2]Reference group includes 226 children; Net = Difference between study and reference group.
[3]Excludes reference group measurements before 10/91.

Table 7. Summary Statistics for Unadjusted Initial Mean Blood Lead Levels (µg/dl) for the Study Group and Reference Group by Measurement Type and Gender.

GROUP	STATISTIC	MEASUREMENT TYPE[1]					GENDER			OVERALL
		CC	CV	VV	VC	MISSING	MALE	FEMALE	MISSING	
STUDY	Mean	**20.1**	**21.4**	**21.3**	**19.6**	**21.3**	**21.1**	**20.9**	**24.0**	**21.0**
	S. Deviation	2.79	1.72	2.09	5.08	2.78	2.38	2.94		2.63
	Sample Size	(37)	(29)	(65)	(10)	(46)	(107)	(79)	(1)	(187)
REFERENCE	Mean	**22.1**	**22.0**	**21.8**	**22.3**	**21.5**	**21.8**	**21.9**	**21.2**	**21.8**
	S. Deviation	1.38	1.32	1.48	1.49	1.24	1.40	1.36	1.17	1.38
	Sample Size	(49)	(21)	(71)	(10)	(75)	(123)	(90)	(13)	(226)
REFERENCE From 10/91[2]	Mean	**22.0**	**21.8**	**21.9**	**22.2**	**21.6**	**21.8**	**21.9**	**N/A**	**21.8**
	S. Deviation	1.45	1.22	1.41	1.56	1.18	1.38	1.29		1.34
	Sample Size	(34)	(18)	(54)	(9)	(41)	(95)	(61)	(0)	(156)

[1]CC = Both measurements are capillary; CV = First is capillary, second is venous;
VC = First is venous, second is capillary; VV = Both are venous.
MISSING = Type of one or both of the measurements unknown.
[2]Excludes reference group measurements before 10/91.

Table 8. Analyses of Variance for Changes in Blood Lead Levels Due to Intervention, Gender, and Measurement Type[1].

SOURCE	DF	TYPE I SS	F-VALUE	PR > F
Intervention[2]	1	838.2	20.5	< 0.001
Sex[3]	1	131.3	3.2	0.08
Sex*Intervention[4]	1	13.7	0.3	0.57
First Measurement Type[5]	1	73.2	1.8	0.19
Second Measurement Type[6]	1	0.1	0.0	0.97

[1]Observations with missing data for sex and measurement type are excluded.
[2]Row entries show whether changes in PbB are different for intervention vs. reference groups.
[3]Row entries show whether changes in PbB (for both intervention and reference groups) differ by sex.
[4]Interaction between sex and intervention type. Shows whether intervention effectiveness differs by sex.
[5]First measurement is capillary or venous.
[6]Second measurement is capillary or venous.

Table 9. Summary of Major Results. The 95% Confidence Intervals are Enclosed in Brackets.

DATA	GROUP	DECLINE IN PBB MEASUREMENTS µg/dl	AVERAGE INITIAL MEASUREMENT µg/dl	PERCENT DECLINE
Adjusted Data	Study	4.24 [3.3, 5.2]	20.0	21 [16, 26]
	Reference	1.18 [0.2, 2.2]	21.2	6 [1, 10]
	Difference[1]	3.06 [1.6, 4.5]	N/A	15 [8, 23]
Unadjusted Data	Study	4.12 [3.2, 5.0]	21.0	20 [15, 24]
	Reference	1.24 [0.3, 2.2]	21.8	6 [1, 10]
	Difference[1]	2.88 [1.5, 4.3]	N/A	14 [7, 20]

[1]The difference between the Study group and the Reference group.

between measurements is increased. The slopes of the regression lines, -0.20 µg/dl per month for the study group versus -0.35 µg/dl per month for the reference group were not significantly different.

The fit to a model (excluding observations from children with unrecorded sex and age) that describes the relationship between the change in the adjusted blood lead levels and the time between measurements reasonably well is:

(1) $Y = -0.00 - .25*t$ for the reference group
$= -2.58 - .25*t$ for the study group,
where t = time between measurements in months, and
Y = second measurement (µg/dl) - first measurement (µg/dl).

In the model used to obtain equation 1, unlike the models used in figures 4 and 5, the slopes of the equations were assumed to be equal. Thus, the rate of decrease in blood lead (in this case estimated to be 0.25 µg/dl per month) were assumed to be the same for both the reference and study groups. Equation 1 suggests that the outreach interventions may have caused an initial relatively abrupt drop in average PbB levels of 2.58 µg/dl, followed by a decline of about 0.25 µg/dl per month. An approximate 95% confidence interval for the initial drop in PbB levels is 1.0 to 4.2 µg/dl. This result is very similar to the estimates of intervention effectiveness derived from the summary statistics in Table 4.

Equation 1 is used to obtain only a very approximate characterization of how blood lead levels decrease after an outreach intervention. The data contains too much variation to determine how rapidly or extensively blood lead levels drop within the first few weeks after an intervention. The regression estimates are also greatly influenced by pairs of PbB measurements with large time differences between measurements. The average time between measurements was about 6.7 months the study group and 6.1 months for the reference groups. For several children the time between measurements was greater than two years.

Figures 6 and 7 show that there is no substantial relationship between decreases in PbB and age. The slopes of the regression lines (-.22 and .25 µg/dl per month for the study and reference groups) are not significantly different from 0.

2.2 DEFINING THE REFERENCE GROUP

The analysis summarized in the previous section was based upon the assumption that prior to the visits of the outreach workers, the study and reference groups were similar with respect to factors associated with blood lead levels. Exclusion criteria for the timing of the measurements in the reference group were defined to satisfy this assumption. This section discusses reasons for defining the reference group to include children with initial elevated (20-24 µg/dl) measurements from 1990-March, 1994. The discussion compares this choice to two other groups defined by time intervals starting from a) 1984, the beginning of computerized Milwaukee Health Department records of blood lead levels, and b) October, 1991, the beginning of the outreach program.

A simple choice for a reference group would have been to include children with measurements from 1984. However, data collected before 1990 was excluded in part because the pre-1990 data was representative of only the early participants in the Milwaukee blood lead testing program. These early participants formed only a small minority of the children who lived in Milwaukee during the 1980's. The children tended to live in sectors of the city targeted by the city's program to reduce lead exposure, because these sectors were thought to have high concentrations of children with elevated blood lead levels. Also, there were concerns that the pre-1990 measurements were far more variable than measurements from the 1990's.

Another obvious approach would have been to define the reference group to include only children with pairs of measurements after the start of the outreach program in October, 1991. Unfortunately, many of the families of these later reference group children were simply unavailable for an outreach visit. The groups would not be directly comparable if non-availability was an indicator of family behavior patterns associated with the continued elevation of children's blood lead levels.

Defining the reference group to include only children with measurements from 1990 balanced concerns discussed in the previous two paragraphs. Certainly, the inclusion of children with measurements before the start of the outreach program raised concerns that the analysis could have been adversely affected by changing time trends in blood lead levels. However, it seemed unlikely that the time trends would have changed enough within two years to have had much of an effect. Also, note that many of the 70 reference group children (see Table 10) with elevated measurements before October, 1991 (in contrast to the other reference group children) would have received an outreach visit if the program had been already established.

Table 10 compares changes in unadjusted blood lead levels by time period for children who did not receive outreach visits. (Measurements before 1990 could not be adjusted for seasonality). The paired measurements increased before 1990, and decreased during the early 1990's. At first glance, Table 10 seems to indicate that the blood lead measurements of children measured after September, 1991 (average change = -0.25 µg/dl) may have differed substantively from children measured between 1990 to September, 1991 (average change = -3.46 µg/dl). However, much of the difference was attributable to the 41+34=74 pairs of measurements of unknown (MISSING) measurement type. In fact, an analysis (which accounted for the possible effects of measurement type) of the remaining 36+115=151 changes in blood lead measurements found no significant (α=.05) difference in changes in blood lead levels between the two time periods. Thus, data in Table 10 indicates that the reference group, which included

Table 10. Comparison of Summary Statistics for Changes in Unadjusted Blood Lead Levels (µg/dl) for Children who did not Receive an Outreach Visit but had Elevated Blood Lead Measurements between 1984-89, 1990-September, 1991, and October, 1991 to 1994.

GROUP	STATISTIC	MEASUREMENT TYPE[1]					GENDER			OVERALL
		CC	CV	VV	VC	MISSING	MALE	FEMALE	MISSING	
1984-1989	Mean	**4.40**	**2.33**	**12.00**	**1.00**	**2.44**	**3.29**	**4.59**	**1.91**	**2.96**
	S. Deviation	5.13	8.39	11.14		8.16	6.44	10.34	7.92	8.14
	Sample Size	(5)	(3)	(3)	(1)	(59)	(21)	(17)	(33)	(71)
REFERENCE (1990-9/1991)	Mean	**-3.00**	**-1.33**	**-2.29**	**-4.00**	**-4.41**	**-2.68**	**-4.97**	**-1.77**	**-3.46**
	S. Deviation	9.06	6.43	5.83		6.96	5.98	8.17	6.37	7.06
	Sample Size	(15)	(3)	(17)	(1)	(34)	(28)	(29)	(13)	(70)
REFERENCE (10/1991-1994)	Mean	**-0.71**	**-1.39**	**-1.22**	**2.78**	**1.24**	**0.84**	**-1.95**	**N/A**	**-0.25**
	S. Deviation	7.45	7.50	6.28	10.23	6.00	6.88	6.67		6.91
	Sample Size	(34)	(18)	(54)	(9)	(41)	(95)	(61)	(0)	(156)

[1]CC = Both measurements are capillary; CV = First is capillary, second is venous;
VC = First is venous, second is capillary; VV = Both are venous.
MISSING = Type of one or both of the measurements unknown.

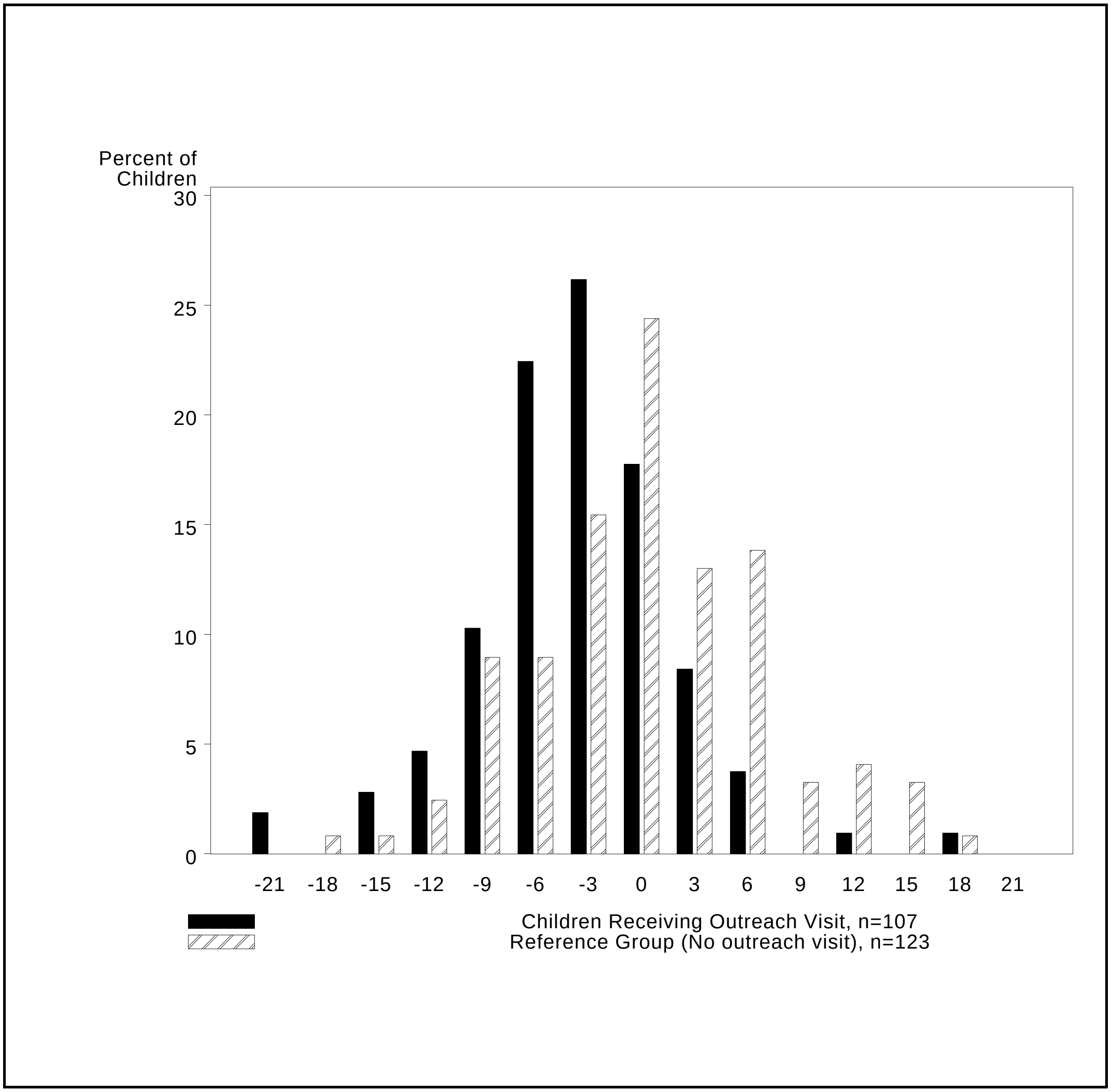

Figure 2. Frequency distribution for Male Children: Changes in Adjusted Blood Lead Levels (µg/dl).

measurements from 1990, allowed for a reasonable assessment of the effects of outreach intervention. The data also did not provide strong evidence for the existence of rapidly changing time trends in actual blood lead levels.

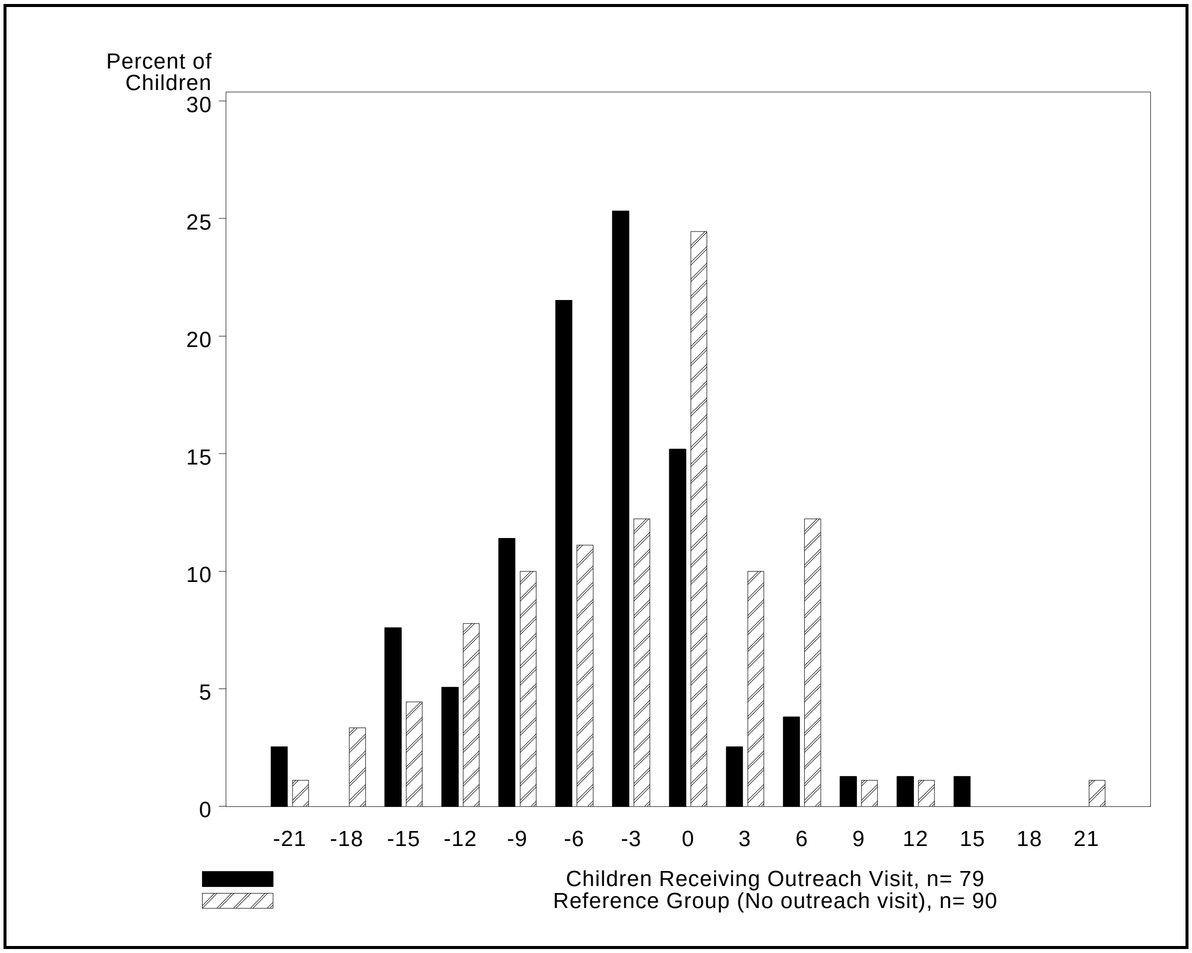

Figure 3. Frequency Distribution for Female Children: Changes in Adjusted Blood Lead Levels (µg/dl).

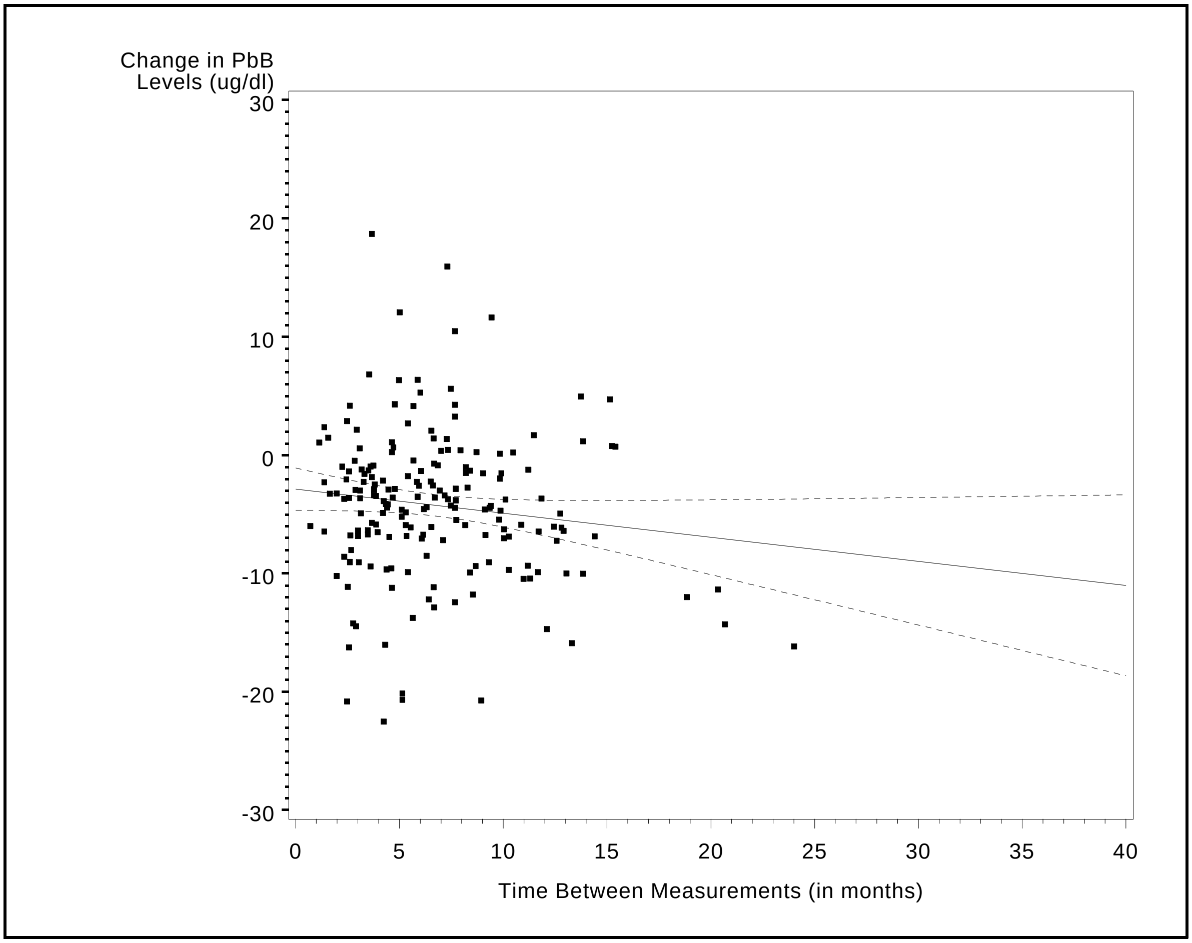

Figure 4. Outreach Study Cases: Change in Adjusted Blood Lead Levels (µg/dl) by Time Between Measurements.

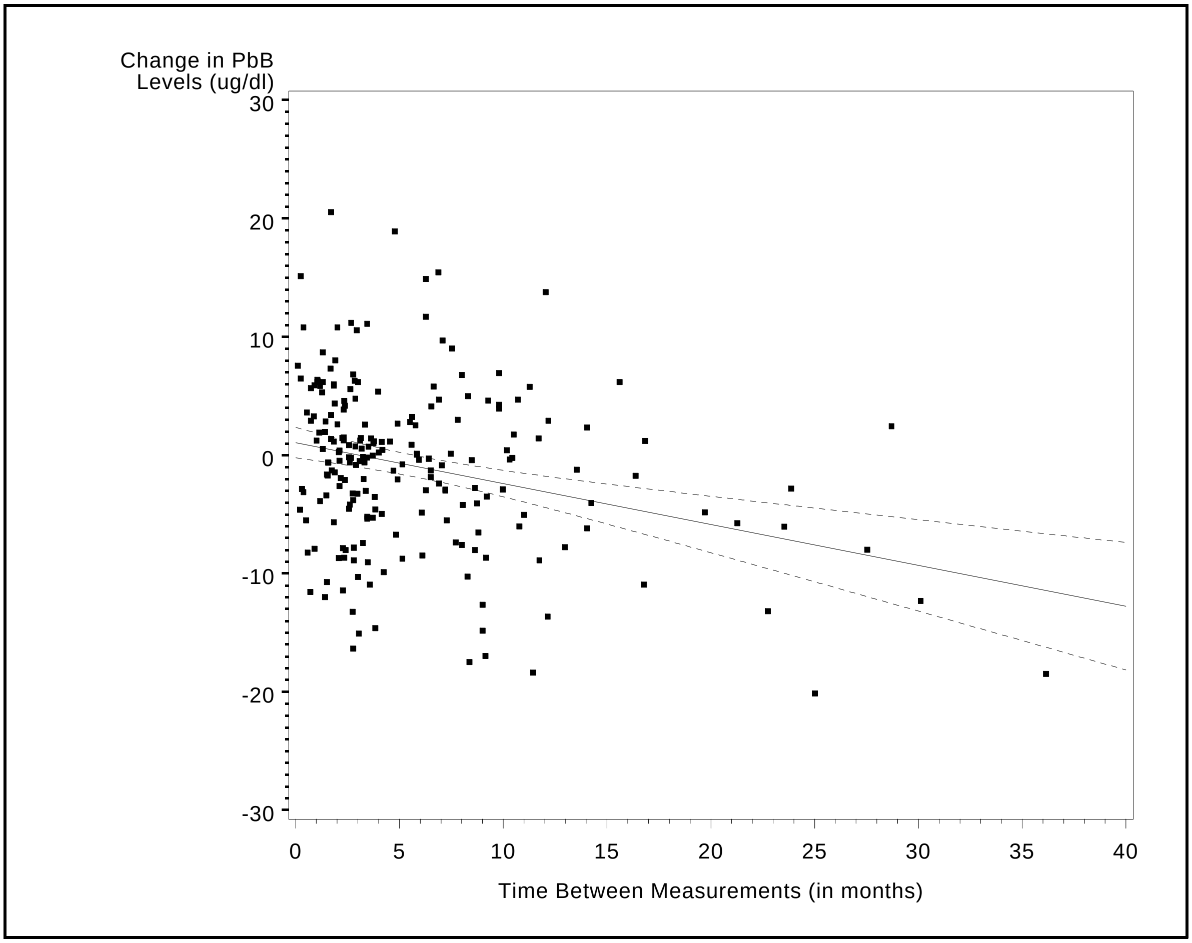

Figure 5. Reference Group Cases (1990-93): Change in Adjusted Blood Lead Levels (µg/dl) by Time Between Measurements.

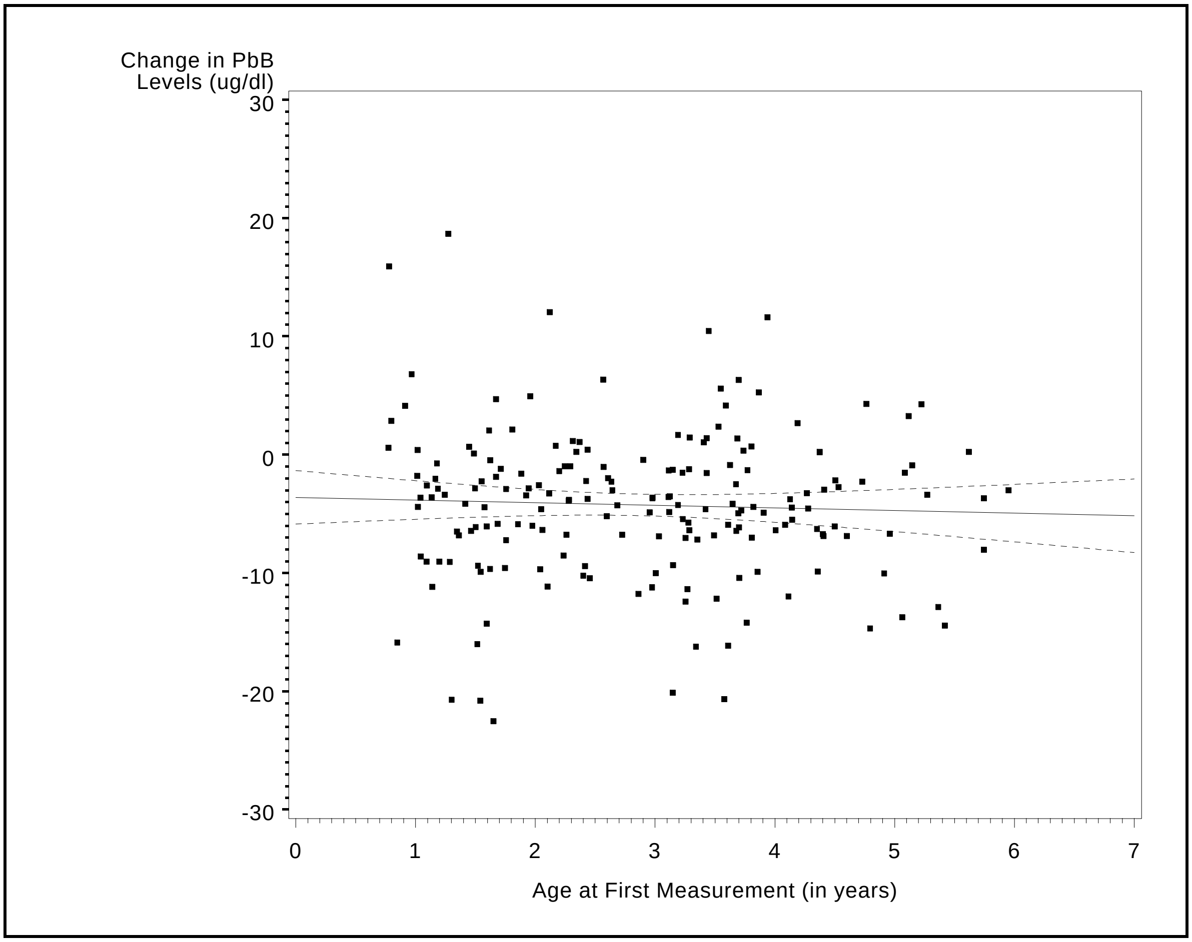

Figure 6. Outreach Study Cases: Change in Adjusted Blood Lead Levels (µg/dl) by Age.

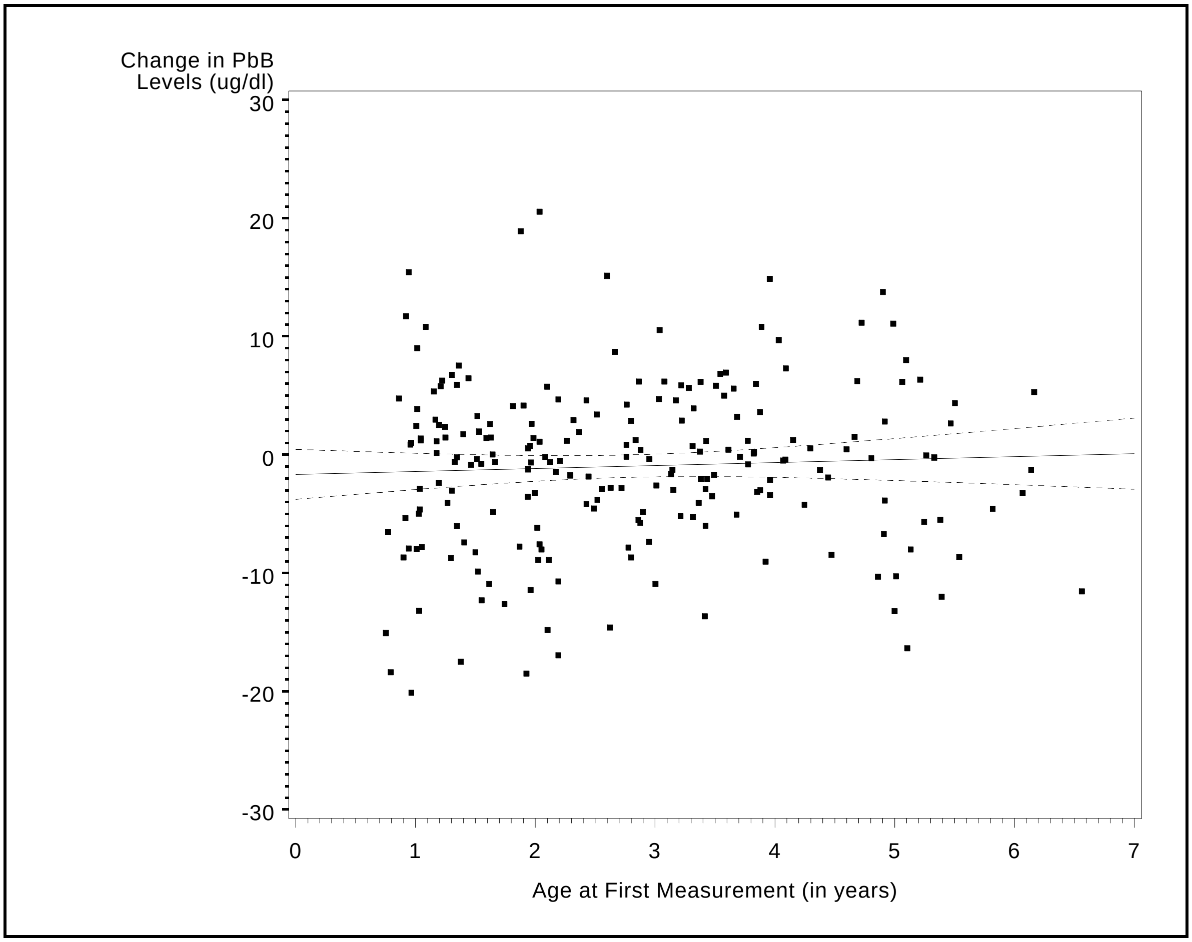

Figure 7. Reference Group Cases (1990-93): Change in Adjusted Blood Lead Levels (µg/dl) by Age.

3 CONCLUSIONS

Declines in blood lead levels were about 15% greater for children who received in-home educational visits than for a reference group of children without interventions. A comparison between study and reference groups is important in any study of intervention effectiveness because of unpredictable changes in average blood lead levels unrelated to interventions. In this study, average blood lead level declines were about 21% for children who received home visits, and 6% for children in the reference group. The average time between measurements was about six months. Results from this retrospective study indicate that the visits were responsible for a marginal decline of 8% to 23% in blood lead levels.

The validity of this conclusion depends on whether the children who received outreach visits were comparable to the reference group children whose families were often unavailable for outreach visits. Families that were unavailable for outreach visits may have been more likely to exhibit behavior patterns responsible for the continued elevation of their children's blood lead levels. Nevertheless, an examination of available data on demographics and blood lead levels indicated the two groups were comparable. The two groups had similar age distributions, racial characteristics, average baseline blood lead levels, and average times between initial and followup blood lead measurements. A complicating factor, common to retrospective studies, was the considerable loss of followup. About one half of the children who received an outreach visit did not have a followup measurement.

Blood lead measurements were adjusted to control for effects of seasonality and age, but the seasonality and age adjustments had very little effect on the final results. Nevertheless, seasonality and age effects may be important factors in analyses of the effectiveness of other interventions, especially when pre- and post-intervention measurements occur in different seasons of the year, or there are large time lags between measurements.

Outreach visits are relatively inexpensive, with total health department costs estimated to be in the range of $100 per visit. The results of this study indicate that educational interventions can be a useful and inexpensive component of lead exposure reduction programs.

REFERENCES

Baghurst P, Tong S, McMichael A, Roberson E, Wigg N, Vimpani G (1992). "Determinants of blood lead concentrations to age 5 years in a birth cohort study of children living in the lead smelting city of Port Pirie and surrounding areas." Archives of Environmental Health, 203-210.

Burgoon D, Rust S, Schultz B (1994). "A summary of studies addressing the efficacy of lead abatement, " in Lead in Paint soil, and Dust: Health Risks, Exposure Studies, Control Measures, Measurement Methods, and Quality Assurance, ASTM, STP 1226, Michael E. Beard and S.D. Allen Iske Eds., American Society for Testing and Materials, Philadelphia.

Centers for Disease Control (1993). Stellar User Guide.

Charney E, Kessler B, Farfel M, Jackson D (1983). "Childhood Lead Poisoning: A Controlled Trial of the Effect of Dust-Control Measures on Blood Lead Levels." New England Journal of Medicine, 309:1089-1093.

Cooney GH, Bell A, McBride W, Carter C (1989). "Low-level exposures to lead: the Sydney Lead Study." Developmental Medicine and Child Neurology, 31:640-649.

Kimbrough R, LeVois M, Webb D (1994). "Management of children with slightly elevated blood lead levels." Pediatrics, 93: 188-191.

McCusker J (1979). "Longitudinal changes in blood lead level in children and their relationship to season, age and exposure to paint or plaster." American Journal of Public Health. 69:348-52.

Pawel D, Foster C, Cox D (1995). "Seasonal Trends in Blood Lead Levels in Milwaukee: Statistical Methodology." Report to the Environmental Protection Agency, 401 M St., S.W., Washington, D.C.

United States Environmental Protection Agency (1995). "Review of Studies Addressing Lead Abatement Effectiveness." Report EPA 747-R-95-006 (available by calling 1-800-424-LEAD).

APPENDIX A. DATABASE DEVELOPMENT

The Milwaukee Health Department uses a software package, "STELLAR", as the lead case tracking system. This system includes four modules: case, address, investigation, and lab. The case data file contains information pertaining to a child's name, sex, race, guardian, number of siblings, and status relating to blood lead levels. The address identification file contains the address identifier, street address, county, city, zip code, and census tract. The investigation file contains information on the address such as year of construction, inspection date, abatement date, etc. The lab file contains information about childrens' blood lead levels, the sampling date, the sampling type, date of birth, providers's name, etc. All four data files can be linked by the child identifier and address identifier. The four Milwaukee data files were used in the analysis of the in-home educational intervention.

1. STELLAR Files

QuanTech received an original set of four ASCII data files from the Milwaukee Health Department on September 23, 1992. These files, which came from files of the lead case tracking system included: ADDRESS.BAS, CASE_RCD.BAS, INVEST.BAS, and LAB.BAS. Two more sets of updated data files were received from the Health Department in August, 1993 and July, 1994. These four files were converted into corresponding SAS files having the same name but with an SSD extension. The ADDRESS.BAS file contained 32,679 observations and 9 variables; the CASE_RCD.BAS file contained 29,333 observations and 56 variables; and the INVEST.BAS file contained 4,628 observations and 47 variables. All three LAB.BAS files were concatenated bringing it to a total of 75,084 observations and 26 variables. Among the 138 variables in the four files, only the 46 variables need for the analysis were included in the final database.

2. Transposing Data

The LAB file is a large file containing records for all reported blood lead level measurements. This file also includes the corresponding date the sample was obtained, the sample type, the address identifier, etc. Investigating the lead levels for each child over time is the main reason for setting up this database, so it was important to have one record per child per address with the respective measurements, dates, and types. (A separate record was kept for each address since moves are major events that may affect blood lead levels). The number of measurements differs by child. The LAB file was sorted by CHILD_ID (the unique identifier), ADDR_ID (the address identifier), and SMPOBTDT (the date the sample was taken) and transposed by CHILD_ID and ADDR_ID. This smaller file contains 52,719 records with 92 variables: CHILD_ID, ADDR_ID, PBB1-PBB30, DT1-DT30, and TYP1-TYP30. For each child, PBB1-PBB30 contains up to 30 lead measurements, DT1-DT30 contains the corresponding dates, and TYP1-TYP30 contains the corresponding measurement methods (i.e capillary, venous, or unknown).

The file was transposed in the following manner. Suppose a child with CHILD_ID=10001 had three measurements at the same location on 1/15/92, 2/15/95, and 3/15/95. The original LAB file would contain three records with CHILD_ID=10001, with one record per measurement. The transposed file would contain one record for CHILD_ID=10001 with three measurements (stored in variables PBB1-PBB3), three dates (DT1=1/15/92, DT2=2/15/92, and DT3=3/15/92), and three sample types (stored in variables TYP1-TYP3). The variables, PBB4-PBB30, DT4-DT30, and TYP4-TYP30 would be set to missing. For children with measurements at multiple locations, the transposed file contains multiple records with the corresponding measurements. For example, if a child (CHILD_ID=20001) had three measurements at ADDR_ID=100 and two measurements at ADDR_ID=200 then the transposed file would contain two records for CHILD_ID 20001. For the first record CHILD_ID=20001, ADDR_ID=100 and the three measurements, dates, and types would be stored in variables PBB1-PBB3, DT1-DT3, and TYP1-TYP3. The second record would have CHILD_ID=20001 and ADDR_ID=200 with values for two measurements, dates, and types.

3. Merging All Files

Once the LAB file was transposed into a workable format, cases were examined to determine whether they should be included in the final database. The specific cases of interest are children with at least two blood lead measurements (non-FEP measurements) and children living in the city of Milwaukee. Children who lived in other cities were excluded from the final database since treatment outside Milwaukee may differ. Only cases having more than one blood lead measurement were kept in the transposed database. Cases with only PBB measurements = 0 were deleted. (A zero was recorded in STELLAR whenever only an FEP measurement was taken).

Initial analysis of the data showed that 75 - 100 percent of the data fields in the CASE_RCD.SSD and INVEST.SSD files had missing values. Therefore, it was necessary to enter and verify data from paper files. The Milwaukee Health Department hard copy files were used three separate times (corresponding to the three times data was received by QuanTech). The SAS database was converted into a working data entry file (a Lotus spreadsheet) using the Translate Utility of Lotus Version 2.2 software.

4. Child Address

An important issue in developing this database is the ability to track changes in the address of a child. Cases of most interest are those children with more than one measurement at one particular address. A child with multiple measurements at more than one location will appear in the database as many times as the number of locations. All measurements, dates, and types for each child are verified and based on the findings, additional records are added into the Lotus file when necessary. A new variable, MOVEFLAG, was defined to indicate which children had moved.

5. Data Verification

Because about 75% of the electronic database contained some missing values (mostly from the "INVEST.BAS" file), updating and verifying these records was time consuming.

The process included tracking each case back to the original hardcopy files that had been used during data entry. The final database containing 10,624 cases was divided into eighteen Lotus files and updated one file at a time. After the first Lotus file (about 500 records) was updated it was decided to update only those records where an abatement occurred. The initial set of data received in 1992 was completely verified and updated by August 1993. The second set of data received in 1993 was completely verified and updated by November 1993. The final set of data received in 1994 was completely verified and updated by February 1995.

6. Checking for Potentially Erroneous Data

Several data anomalies associated with this study warranted further investigation, including the occurrence of two or three consecutive measurements with identical blood lead levels or extremely high PbB measurements.

Several records were found in Stellar that contained two or three consecutive identical blood lead measurements. These measurements were verified several ways. Files that contained consecutive duplicate measurements (same value and same date) were compared to Public Health Nursing records. It was determined that duplicate measurements in the Stellar files with the same sample collection date were data entry errors, and only one of the entries was retained in the database.

Stellar files that contained three consecutive identical measurements were referenced against the original lab sheets stored at the Milwaukee Health Department. They did not appear to be data entry errors.

Blood lead measurements that were abnormally high were also investigated. CHILD_ID 11772 had a PbB reported of 201 µg/dl. After checking nursing records it was found that this was an FEP measurement and not a blood lead value. CHILD_ID 433 had a PbB of 97 µg/dl. This capillary sample may have been contaminated. Capillary measurements may be affected by contamination when proper aseptic techniques are not followed during the sample collection.

APPENDIX B. DATA ADJUSTMENT PROCESS

Blood levels were adjusted through basically a four step process. First, 90th percentiles were calculated to summarize PbB levels for each semimonthly period from 1990 through 1993. Second, the 90th percentile PbB values were fit to a model so that long-term trends in PbB could be removed. Additive seasonal adjustments were then based on moving averages of the detrended 90th percentile PbB values. Finally, multiplicative age adjustments were calculated as simple ratios of arithmetic means using predefined age categories. The result are adjusted PbB values which approximate the PbB values that would have been observed during the first half of January, 1993 had the children been 1.75-2 years old.

Adjustments factors were not calculated before 1990, because of concerns about the quality, quantity and relevance of pre-1990 Milwaukee blood screening data. Thus, measurements in the reference group database made before 1990 were not adjusted. All measurements for the study group were made after 1989 and were adjusted.

A difficult step of the process was detrending the data, because of uncertainty about the effect on PbB values of procedural changes in October, 1991. To allow for a crude sensitivity analysis, the data were detrended two ways resulting in two sets of adjusted PbB values. For the first set of adjusted PbB values (linearly detrended adjusted PbB values), the 90th percentiles were detrended assuming a simple linear decline in PbB values. Results in the main body of the report were based upon this set of adjusted PbB values.

The second set, used mainly to check the sensitivity of analysis of variance results to the method used to generate the adjustment factors, allowed for a sudden change in PbB values occurring in October, 1991. An analysis of variance table and summary statistics based on the second set of adjusted PbB values or "adjusted PbB values using the procedural correction" are shown in Tables 11 through 13.

Table 11. Analyses of Variance for Changes in Blood Lead Levels Due to Intervention, Gender, and Measurement Type[1].

ADJUSTMENTS MADE WITH PROCEDURAL CORRECTION				
SOURCE	DF	TYPE I SS	F-VALUE	PR > F
Intervention[2]	1	475.5	11.8	< 0.001
Sex[3]	1	128.3	3.2	0.08
Sex*Intervention[4]	1	17.2	0.4	0.51
First Measurement Type[5]	1	66.9	1.7	0.20
Second Measurement Type[6]	1	0.3	0.0	0.93

[1]Observations with missing data for sex and measurement type were excluded.
[2]Row entries show whether changes in PbB are different for intervention vs. reference groups.
[3]Row entries show whether changes in PbB (for both intervention and reference groups) differ by sex.
[4]Interaction between sex and intervention type. Shows whether intervention effectiveness differs by sex.
[5]First measurement is capillary or venous.
[6]Second measurement is capillary or venous.

Table 12. Summary Statistics for Changes in Blood Lead Levels Adjusted Using Alternative Method[1].

GROUP	STATISTIC	MEASUREMENT TYPE[2]					GENDER			OVERALL
		CC	CV	VV	VC	MISSING	MALE	FEMALE	MISSING	
STUDY	Mean	**-4.28**	**-3.75**	**-3.15**	**-3.63**	**-2.92**	**-2.97**	**-4.08**	**-1.66**	**-3.44**
	S. Deviation	5.26	5.21	6.16	10.03	6.83	5.80	6.81		6.28
	Sample Size	(37)	(29)	(65)	(10)	(46)	(107)	(79)	(1)	(187)
REFERENCE	Mean	**-1.78**	**-0.81**	**-1.05**	**2.30**	**-1.37**	**0.42**	**-2.80**	**-4.47**	**-1.14**
	S. Deviation	6.86	7.23	6.07	6.88	8.30	6.59	7.34	8.01	7.17
	Sample Size	(49)	(21)	(71)	(10)	(75)	(123)	(90)	(13)	(226)
NET	Mean	**-2.50**	**-2.94**	**-2.10**	**-5.93**	**-1.55**	**-3.39**	**-1.28**	**2.81**	**-2.30**
	S. Error	1.31	1.92	1.05	3.85	1.39	0.82	1.09	8.31	0.66
REFERENCE From 10/91	Mean	**-0.80**	**-1.10**	**-1.15**	**3.44**	**2.75**	**1.21**	**-1.31**	**N/A**	**0.22**
	S. Deviation	6.74	7.67	6.61	6.21	6.34	6.76	6.74		6.84
	Sample Size	(34)	(18)	(54)	(9)	(41)	(95)	(61)	(0)	(156)
NET	Mean	**-3.48**	**-2.65**	**-2.00**	**-7.07**	**-5.67**	**-4.18**	**-2.77**	**N/A**	**-3.66**
	S. Error	1.44	2.05	1.18	3.79	1.41	0.89	1.15		0.71

[1]Alternative method is based on use of procedural term.
[2]CC = Both measurements are capillary; CV = First is capillary, second is venous;
VC = First is venous, second is capillary; VV = Both are venous.
MISSING = Type of at least one measurement is unknown.

Table 13. Summary Statistics for Initial Blood Lead Levels Adjusted Using Alternative Method[1].

GROUP	STATISTIC	MEASUREMENT TYPE[2]					GENDER			OVERALL
		CC	CV	VV	VC	MISSING	MALE	FEMALE	MISSING	
INTERVENTION	Mean	**18.7**	**19.0**	**19.9**	**18.8**	**20.3**	**19.3**	**19.8**		**19.5**
	S. Deviation	3.08	3.05	2.88	6.64	4.81	3.71	3.90		3.78
	Sample Size	(37)	(29)	(65)	(10)	(46)	(107)	(79)	(1)	(187)
REFERENCE	Mean	**21.3**	**20.6**	**20.7**	**22.2**	**21.0**	**21.0**	**20.7**	**22.8**	**21.0**
	S. Deviation	3.56	3.60	2.79	3.96	3.68	3.30	3.14	5.30	3.39
	Sample Size	(49)	(21)	(71)	(10)	(75)	(123)	(90)	(13)	(226)
REFERENCE From 10/91	Mean	**20.9**	**20.4**	**21.0**	**21.9**	**20.0**	**20.9**	**20.5**	**N/A**	**20.7**
	S. Deviation	3.00	3.82	2.85	4.04	2.99	3.20	2.87		3.07
	Sample Size	(34)	(18)	(54)	(9)	(41)	(95)	(61)	(0)	(156)

[1]Alternative method is based on use of procedural term.
[2]C = Both measurements are capillary; CV = First is capillary, second is venous;
VC = First is venous, second is capillary; VV = Both are venous.
MISSING = Type of one or both of the measurements unknown.

APPENDIX C. COST OF IN-HOME EDUCATIONAL VISITS IN MILWAUKEE

(This appendix reproduces a note from Brad Schultz to Amy Murphy which describes an informal analysis of the costs of outreach visits in Milwaukee.)

Note to: Amy Murphy, Milwaukee Health Department
From: Brad Schultz, U.S. Environmental Protection Agency
Subject: An informal analysis of the costs of MHD outreach visits.

Based on information from the Milwaukee Health Department, we have come up with some "ballpark" estimates of the cost per visit of the in-home educational visits by the MHD outreach workers. In comparison with what other health departments might do, I would place the program development activities and implementation on a per visit basis at a fairly inexpensive level as the health department is using relatively low-skilled para-professionals for the in-home outreach educational visits.

There are two components of this cost per visit estimate: (1) the cost per year of the outreach worker; and (2) the numbers of visits that they could make if completely devoted to making in-home educational visits.

(1) The cost per year of the outreach worker is approximately $30,000 per year, including salary, benefits, car mileage and cellular telephone. It is estimated that the outreach worker requires an extra 10% of supervisory time for the outreach program, and this cost is 10% of $60,000, or $6,000 per year. The total cost of the outreach worker is then $36,000.

(2) I am estimating that the number of weeks that the outreach worker could make visits is 52 weeks per year - (6 weeks of vacation/holiday/sick leave) - (1 week full-time training) = 45 weeks. I am also estimating two visits per day on average for 3 days of the week and one visit for the other two days. The other time is used for unsuccessful attempts at making educational visits, paperwork in the office, and staff meetings. In this scenario, no time is allocated for activities other than in-home educational visits and work directly related to supporting those visits.

From those two pieces, I am estimating roughly that there are 45 weeks of visits, times 8 visits per week, for 360 visits per year. The cost of those visits would be $36,000, thus resulting in <u>an average cost of $100 per visit</u>. My guess is that it is very <u>possible that the real cost could be twice this amount or half this amount</u>.

The number of visits is probably somewhat conservative since it is difficult to completely remove other duties from the outreach worker time. But it also reflects the fact that the majority of visits by the Milwaukee Health Department are cold calls (no appointment), as eventually a higher percentage of families are reached this way, and since many of the families have no phones to call to make an appointment. On the other hand, there may be a tendency to underestimate costs a little since some costs may be overlooked. But overall, I have no reason to suspect that the cost per visit estimate is too high or too low.

Start up costs are very hard to estimate at this point, but may have been around $10,000 for the Milwaukee Health Department. This includes purchasing equipment, management time to learn about and develop the program, deciding what materials to hand out, and so forth.

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15. Supplementary Notes

In addition to the authors listed above, Jill LeStarge of Quantech was a major contributor to the study.

16. Abstract (Limit: 200 words)

Education and counseling have recently been recognized as potentially effective, and relatively inexpensive components of programs for reducing blood lead levels in children. The purpose of this retrospective analysis was to determine whether blood lead levels declined after in-home educational visits by Milwaukee Health Department staff to homes of children with elevated blood lead levels, usually between 20-24 µg/dl. During the educational visits, hazards associated with childhood lead exposure were described, and potential sources of the hazards were identified. The importance of the child's personal hygiene, nutrition, and overall dust reduction and cleaning practices were also discussed. Data were gathered from 1990 to 1994.

Average blood lead measurements were about 21% lower after intervention than before intervention. Blood lead levels in a reference group of children who did not receive the interventions also declined, but by about 6%. The difference in the average declines in blood lead levels yielded an estimate of net effectiveness of outreach intervention of 21%-6%=15% with a 95% confidence interval of 8% to 23%. The educational interventions appear to be a useful component of lead exposure reduction programs.

17. Document Analysis a. Descriptors

Lead exposure reduction, children, blood lead levels, educational intervention

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