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Evaluation of the HUD Lead Hazard Control Grant Program: Early Overall Findings[1]

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This study evaluates the effectiveness of lead hazard control methods used in the Lead Hazard Control (LHC) grant program of U.S. Department of Housing and Urban Development. The LHC Program awards funds to local jurisdictions to address lead hazards in privately owned, low-income dwellings. Grantees in 14 cities, states, or counties collected environmental data in over 2600-treated dwellings making this the largest study of residential lead hazard control ever undertaken. Grantees employed a range of treatments, the most common being replacement of windows and repair of deteriorated lead-based paint. In this paper, dust lead loading levels and blood lead levels of children (6 months-6 years, if present) were observed at four periods of time (preintervention, immediate, and 6- and 12-months postintervention) in 1212 dwellings. Dust lead loading levels were also observed in a subset of these dwellings at 24- and 36-months postintervention. The geometric mean floor and window dust lead loadings declined at least 50 and 88% (*P*< 0.0001), respectively, immediately postintervention. Three years later, floor dust lead loadings remained at or below the immediate postintervention levels. Window dust lead loadings had moderate increases, but remained substantially reduced from preintervention levels and below clearance standards. At 1 year after intervention, geometric mean age-adjusted blood lead levels had declined from 11.0 to 8.2 μg/dL, a 26% decline (*P*< 0.0001). The LHC Program interventions produced blood lead declines similar to or greater than the percentage changes reported in earlier 1-year lead intervention studies. © 2001 Academic Press

Key Words: **blood lead; lead-contaminated dust; lead hazard control; child; environmental exposure; lead poisoning; evaluation studies.**

INTRODUCTION

In 1991, the United States Congress began funding grants to assist State and local governments with the control of lead-based paint hazards in low-income, privately owned housing. The U.S. Department of Housing and Urban Development (HUD) administers the funds, known as the HUD Lead-Based Paint Hazard Control Grant Program ("the HUD LHC Grant Program"). Congress intended the first year of funding to support an examination of the effectiveness of various lead hazard control strategies (U.S. Congress, 1991). This paper reports early findings from the evaluation of the program.

The Centers for Disease Control and Prevention (CDC) estimates that 890,000 children below the age of 6 in the United States (4.4%) have a blood lead level of 10 μg/dL or above (Pirkle *et al.*, 1998; CDC, 1997). The CDC defines 10 μg/dL as the level of health concern for children (CDC, 1991). The most common sources of environmental lead exposure for U.S. children are lead-based paint that was applied in homes prior to its being banned in 1978 and lead that has accumulated in dust and soil (Lanphear *et al.,* 1996, 1998a). Children can be exposed by ingesting lead-contaminated dust or soil or by ingesting the paint directly.

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An examination by the U.S. Environmental Protection Agency (EPA) of previous studies of small or moderate-sized lead hazard control projects (154 or fewer homes receiving treatment) found that a range of intervention strategies was shown to reduce children's blood lead levels, but the effectiveness of the individual strategies depended on local conditions (Niemuth *et al*., 1998). The HUD LHC Grant Program provided an opportunity to evaluate the effectiveness of lead hazard control strategies on a much larger, nationwide scale.

The National Center for Lead-Safe Housing and the University of Cincinnati (the evaluators) jointly coordinated the design and implementation of the evaluation of the HUD LHC Grant Program. The evaluation was a collaborative effort between the grant recipients (State and local housing and health agencies), who implemented the hazard control activities and collected the data, and the evaluators, who trained the data collectors, reviewed the quality of data collection and data entry, and analyzed the data. A comprehensive report on the outcomes of the evaluation of the HUD LHC Grant Program is being prepared for publication in late 2001. The paper presented here examines the range of interventions used by the grant recipients and assesses the effectiveness of the HUD LHC Grant Program as a whole based on blood and dust lead data aggregated across the various interventions.

METHODS

Design

In 1993 and 1994, HUD awarded funds to 30 grant recipients (grantees) under the LHC Grant Program (U.S. HUD, 1997). All 11 grantees in 1993 were required to participate in an evaluation of the program, while three 1994 grantees were recruited into the evaluation. The participating grantees included State or local governmental agencies in the following locations: Alameda County, California; Baltimore, Maryland; Boston, Massachusetts; California; Chicago, Illinois; Cleveland, Ohio; Massachusetts; Milwaukee, Wisconsin; Minnesota; New Jersey; New York, New York; Rhode Island; Vermont; and Wisconsin.

Each grantee collected comprehensive environmental data on all treated dwellings (NCLSH UC, 1997). Grantees also attempted to recruit families residing in the dwellings into the evaluation. Families that consented to participate agreed to be interviewed and allowed blood to be drawn from eligible children. Children between 6 months and 6 years of age at enrollment were eligible. Local Institutional Review Boards in the jurisdictions of the grantees reviewed and approved the study designs.

Information was gathered at four periods of time: prior to the start of the lead hazard control work, within 6 weeks after work was completed, 6 months after work was completed, and 12 months after work was completed. HUD awarded funds to nine of the grantees to collect additional longitudinal data in approximately 40% of the dwellings 2 years and 3 years after work was completed.

Data collection began in January 1994. Data were collected from over 2600 treated dwellings in the evaluation. The last dwelling unit was treated in October 1997 and the last 12-month data were collected in October 1998. The last dwelling eligible for the 3-year evaluation was treated in June 1996 and final data were collected for these units in June 1999.

Data submitted by the grantees to the evaluators by February 1, 1999, were used in this analysis. Because not all data in the evaluation had been submitted as of this date, including much of the 3-year data, this paper does not contain all of the data that will be in the final report. The data set used for this paper included 97% of the final 1 and 2 year dust data and 37% of the final 3-year dust data.

Measurements

This paper presents two measures of effectiveness: changes in blood lead concentration and changes in dust lead loading.

Blood lead concentration. Trained phlebotomists obtained blood specimens from participating children. The primary method of collection was venipuncture. On a case-by-case basis, a phlebotomist could make a determination that a venous sample was unattainable and collect a capillary sample instead. Three grantees received approval to use capillary sampling (fingerstick) as their primary blood collection method. Phlebotomists at these sites were trained in proper fingerstick techniques. Fifty-one percent of all blood samples were collected by venipuncture. There was no significant difference in the percentage of samples collected by venipuncture from baseline to the follow-up phases ($P > 0.45$).

Each grantee selected its own laboratory (or laboratories) to analyze the blood specimens. Each laboratory was required to meet the proficiency standards set under the Clinical Laboratory Improvement Act of 1988. Lead was measured by either graphite furnace atomic absorption spectrophotometry or anodic stripping voltammetry (NCLSH UC, 1994). The limits of detection varied by laboratory from 1 to 5 μg/dL. Undetectable levels are assigned a value of the detection limit divided by the square root of 2 (Hornung and Reed, 1990).

Grantees were required to submit blinded quality control samples to the laboratories on a regular basis. The quality control samples were prepared by the CDC from whole bovine blood pools. The evaluation quality control officer worked with any laboratory whose performance fell outside of the quality control standards set in the study protocols (more than 3 μg/dL different from the target value). Blood samples analyzed during a period when a laboratory fell outside of the standards are excluded from this report. A total of 23 blood lead samples were excluded from the total evaluation data set for quality control reasons. Therefore, up to 23 children were excluded from the analyses reported in this paper.

Dust lead loading. Dust samples were collected using a standard single-surface dust wipe collection protocol (U.S. HUD, 1995). Trained inspectors collected the samples in all dwellings. Floor samples were collected from the interior entry to the dwelling, doorways in the youngest child's playroom (or living room), that child's bedroom, a second child's bedroom, and the kitchen. Interior window sill samples were collected from the youngest child's bedroom and kitchen. Window trough samples were collected from the child's playroom and second child's bedroom. Exact sampling locations were determined in the field by the inspector based on the availability and operability of windows and the presence of a second child's bedroom. Inspectors were to return to the same sampling locations in each phase of the evaluation. Inspections alternated the exact location of the sampling from one side to the other of the doorway or window in each phase, to reduce the possible influence of the previous sampling.

Each grantee selected its own laboratory (or laboratories) to analyze the dust samples. A laboratory was required to show evidence that it was proficient under the Environmental Lead Proficiency Analytical Testing Program. Laboratories were not required to be accredited under the EPA National Lead Laboratory Accreditation Program because the study began early in that program's existence and few laboratories were as yet recognized. Lead was measured by flame atomic absorption, graphite furnace atomic absorption, or inductively coupled plasma-atomic emission spectrometry (NCLSH UC, 1994).

Grantees were required to submit double-blind quality control samples to the laboratories on a regular basis. The quality control samples were prepared by the Wisconsin State Laboratory by applying set quantities of NIST Standard Lead Paint Dust (Standard 1578) to a wipe. Dust samples analyzed during a period when a laboratory's values exhibited a pattern of deviation by more than 20% from the target values are excluded from this report.

The method detection limits of the laboratories varied from 1 to 25 μg/ft^2. Midway through the evaluation, it was determined that many dust lead results (e.g., about one-half of the postintervention floor dust lead values) were falling below the limits of detection. Such values would restrict the observations of changes in dust lead levels. To overcome this limitation, the evaluators asked the laboratories to provide the instrument reported value for future samples and previously reported samples. The instrument value, when available, is used in this paper. In the 4–8% of samples where the instrument value was not available, values below detection limits are assigned a value of the detection limit divided by the square root of 2 (Hornung and Reed, 1990). There is no evidence that any variation in the detection limits by phase affected the findings of this paper.

Analyses

The design of the HUD LHC Grant Program encouraged grantees to implement hazard control measures of their choice and did not include the use of control groups. The evaluation was designed to compare the effectiveness of the different classes of interventions that grantees used. Such comparisons involve complex relationships because they must take into account the possible confounding of preintervention conditions with the interventions. Preliminary analyses revealed that grantees tended to use more extensive hazard control measures for housing which posed higher risks of lead poisoning.

The preliminary report focuses solely on the effectiveness of the program as a whole. Descriptive statistics are presented for the longitudinal changes in blood and dust lead levels. Dust lead levels for samples collected after the intervention occurred are compared by time to determine if statistically significant changes occurred. Similarly, postintervention blood lead levels are compared over time to determine if statistically significant changes occurred.

Changes in geometric mean dust lead and blood lead from preintervention to postintervention were compared for the 1212 dwelling units for which dust samples were collected in each of the first four time periods of the 12-month evaluation from at least one of the four specified sampling areas (interior entry

TABLE 1
Frequency of Dwelling Units with Reported Interim Lead Hazard Control Treatments by Location of Work

	Treatment to building exterior		No treatment to building exterior		
Interior work[a]	Soil treatment	No soil treatment	Soil treatment	No soil treatment	Total
Spot painting/cleaning	16	17	0	82	115
Complete painting	10	85	2	7	104
Painting plus window treatments[b]	19	155	8	26	208
Painting plus window abatement[c]	94	544	35	85	758
Full abatement of lead	2	12	0	13	27
Total dwellings	141	813	45	213	1212

[a] Interior treatment levels were defined by the listed categories. At higher treatment levels, the probability that other lead work was conducted (i.e., replacement of doors, trim) increases.
[b] Window treatments include friction controls such as jamb liner installation and the abatement (replacement or paint removal) of few (generally, 1 or 2) windows in dwelling.
[c] Window abatement includes the replacement or paint removal of multiple windows in dwelling.

floors, other interior floors, window sills, and window troughs). For blood lead, statistical significance of changes was determined using ANOVA and adjusting for age of child. Results were not adjusted for season or for the correlation of data within dwellings. Of the 1212 dwellings, 427 dwellings also had dust samples collected at 24 months postintervention and 133 dwellings had dust lead data available from 36 months postintervention. Dust lead changes were separately analyzed from preintervention to 12, 24, and 36 months postintervention. The statistical significance of dust lead level changes was examined using the t test.

RESULTS

The lead hazard control treatments of the HUD LHC Grant Program are characterized by level of interior treatment and presence or absence of exterior and/or soil treatments at the 1212 dwellings (Table 1). Each of the 1212 dwellings had interior treatments, while 954 of the dwellings (79%) had treatments to the exterior of the building, and 186 (15%) had soil treatments. The most common combination of work included the stabilization of paint and replacement of windows, treatments to the exterior, and no soil treatment (544 dwellings (45%)). Only a small set of dwellings had their interior lead fully abated (removed or enclosed) (27 dwellings (2%)).

The dwellings in the analyses were primarily located in the Northeast and Midwest regions of the country (Table 2). Over 45% of the dwellings were in buildings with more than a single dwelling. Approximately half of the dwellings were built before 1910, increasing the probability that the dwellings were painted with multiple layers of lead-based paint. At least 40% of the interior building components tested for lead-based paint were rated as fair or poor using a standard developed by HUD to assess paint quality (U.S. HUD, 1995). The characteristics of the housing and the treatments differed among the three datasets analyzed (Table 2); however, the observed differences did not suggest any consistent bias that would affect the overall results.

Dust Lead Results

Effectiveness of the interventions as measured by changes in dust lead loading through 12 months postintervention is presented for the four dust sample collection locations: interior entryway floors, interior floors, window sills, and window troughs. The arithmetic mean of the one to four interior floor samples in the dwelling represents the interior floor. Likewise, the arithmetic mean of the respective window samples in the dwelling represents the window sill and window trough.

A total of 931 dwellings had entryway floor samples collected in the first four time periods of the evaluation (preintervention, immediate postintervention, 6 months postintervention, and 12 months postintervention). The geometric mean of the dust lead loadings at the interior entry declined from 34 to 12 μg/ft^2 immediately after intervention ($P < 0.0001$), a 65% reduction (Table 3).[3] Similarly, the geometric mean of the average interior floor dust lead loadings ($n = 1{,}178$) declined from 25 to 9 μg/ft^2

[3] At these lower dust lead levels, the precision of the laboratory analysis decreases, so the magnitude of the reported changes may be affected by the increased uncertainty.

TABLE 2

Characteristics of Dwelling Units and Treatments in the 12-, 24-, and 36-Month Study Groups

	12-Month study group (n = 1212)	24-Month study group (n = 427)	36-Month study group (n = 133)
Locations			
Vermont	223 (18%)	41 (10%)	5 (4%)
Milwaukee	171 (14%)	125 (29%)	37 (28%)
Baltimore	164 (13%)	64 (15%)	19 (14%)
Wisconsin	120 (10%)	42 (10%)	8 (6%)
Rhode Island	115 (9%)	43 (10%)	12 (9%)
Minnesota	82 (7%)	56 (13%)	26 (20%)
Other[a]	337 (28%)	56 (13%)	26 (20%)
Age of dwelling			
Pre-1910	587 (48%)	227 (53%)	72 (54%)
1910–1929	458 (38%)	159 (37%)	53 (40%)
1930–1949	133 (11%)	32 (8%)	7 (5%)
Post-1949	34 (3%)	9 (2%)	1 (1%)
Type of building			
Single family	464 (38%)	197 (46%)	71 (53%)
2–4 Units	574 (47%)	201 (47%)	56 (42%)
> 4 Units	173 (14%)[b]	29 (7%)	6 (5%)
Interior paint condition (% of all surfaces tested)			
% Good	56%	55%	60%
% Fair	29%	28%	27%
% Poor	15%	16%	13%
Interior Work			
Spot paint/clean	115 (9%)	38 (9%)	2 (1%)
Complete painting	104 (9%)	54 (13%)	28 (21%)
Window treatments	208 (17%)	100 (23%)	34 (26%)
Window abatement	758 (63%)	226 (53%)	65 (49%)
Full abatement	27 (2%)	9 (2%)	4 (3%)

[a]Other locations include Alameda County, Boston, and California (12–36 months); and Chicago, Cleveland, Massachusetts, and New York City (12 months only).

[b]One dwelling coded as "other."

immediately after intervention ($P < 0.0001$), a 62% reduction. Entry floor dust lead increased by 3 μg/ft^2 from immediately postintervention to 6 months postintervention ($P < 0.01$), but decreased by 2 μg/ft^2 from 6 to 12 months postintervention ($P < 0.01$). There was no evidence of reaccumulation of interior floor dust lead at 12 months postintervention.

The immediate reductions in dust lead levels on window components are even greater than for floors (Table 3). The geometric mean of the average window sill dust lead loading (n = 1,144) declined from 340 to 19 μg/ft^2 ($P < 0.0001$), while the geometric mean of the average window trough dust lead loading (n = 956) declined from 6073 to 27 μg/ft^2 ($P < 0.0001$). These represent 95 and 99.6% reductions, respectively. Like entry floors, there was a small increase from immediately postintervention to 6 months postintervention for both sills and troughs ($P < 0.01$) and a slight decline from 6 to 12 months postintervention ($P < 0.05$). The levels at 1 year, 51 and 398 μg/ft^2, respectively, represented 85 and 93% reductions from the preintervention levels.

For the subgroup of 427 dwellings with 2 years of dust lead data, the results up to 1 year were similar to those of the dwellings enrolled in the 1-year evaluation (Table 4). One difference between the two groups was the preintervention window trough dust lead levels, which were much higher in the 24-month group than in the 12-month group (9437 and 6073 μg/ft^2, respectively). Two years after the interventions, dust lead levels remained low when compared to the preintervention levels. Interior entries and interior floors were both 64% lower ($P < 0.0001$) than the baseline levels. Window sill dust lead levels were 86% below preintervention levels, while window troughs were 95% below baseline ($P < 0.0001$). Window sill and window trough dust lead levels declined from 12 months postintervention to 24 months postintervention (27 and 26% ($P < 0.01$), respectively). For the 133 dwellings for which 36 month postintervention dust lead data were available (Fig. 1) dust lead levels did not change significantly from 24 to 36 months postintervention.

Blood Lead Results

A total of 240 children recruited from the 1212 houses in the 12-month dust lead comparison had blood samples drawn at all four times of the evaluation through 12 months postintervention (Table 5). The children's blood lead levels prior to intervention ranged from 2 to 48 μg/dL, with a median of 10 μg/dL and an interquartile range from 6 to 16 μg/dL. Blood lead concentrations declined slightly (0.4 μg/dL ($P < 0.0001$)) from preintervention to immediately postintervention (an average time duration of 16 weeks). From preintervention to 6 months after intervention, the geometric mean blood lead level declined from 11.0 to 9.3 μg/dL, a 16% reduction ($P < 0.0001$). From preintervention to 12 months after intervention, the geometric mean blood lead level declined by 2.8 to 8.2 μg/dL, a 26% reduction. (Because the number of children (54) with 24-month blood results was limited as of February 1999 and not necessarily representative of the findings of the final dataset, the 2-year results are not presented here.)

TABLE 3

Change in Geometric Mean Dust Lead Loading at Various Postintervention Times by Surface Sampled (12-Month Study Group)

Phase		Dust lead loading (μg/ft²) Interior entry	Interior floors	Window sill	Window trough
Preintervention loading		34	25	340	6073
Change between preintervention	Δ	– 22	– 16	– 321	– 6046
and immediate postintervention[a]	%Δ Pre	– 65%	– 62%	– 95%	– 99.6%
Change between preintervention	Δ	– 19	– 16	– 282	– 5594
and 6-months postintervention[a]	%Δ Pre	– 56%	– 62%	– 83%	– 92%
Change between preintervention	Δ	– 22	– 16	– 289	– 5675
and 12-months postintervention[a]	%Δ Pre	– 63%	– 65%	– 85%	– 93%
Change between immediate and	Δ	3	0	39	452
6-months postintervention	%Δ	25%	1%	216%	1676%
	P value	($P = 0.0006$)	($P = 0.8560$)	($P = 0.0001$)	($P = 0.0001$)
Change between 6-months and	Δ	– 2	– 1	– 7	– 80
12-months postintervention	%Δ	– 15%	– 8%	– 12%	– 17%
	P value	($P = 0.0011$)	($P = 0.0403$)	($P = 0.0169$)	($P = 0.0027$)
Number of dwellings ($n = 1212$)		931	1178	1144	956

[a] All dust lead loading changes are significant at $P < 0.0001$.

DISCUSSION

The lead hazard control interventions conducted in the evaluated dwellings of the HUD LHC Grant program significantly reduced the levels of lead-contaminated dust in the dwellings and those levels remained relatively low (at least 60% below preintervention levels on floors and 75% below preintervention levels on windows) 1, 2, and 3 years after treatment. The interventions and the reductions in

TABLE 4

Change in Geometric Mean Dust Lead Loading at Various Postintervention Times by Surface Sampled (24-Month Study Group)

Phase		Dust lead loading (μg/ft²) Interior entry	Interior floors	Window sill	Window trough
Preintervention loading		33	23	374	9437
Change between preintervention	Δ	– 19	– 12	– 349	– 9402
and immediate postintervention[a]	%Δ Pre	– 58%	– 50%	– 93%	– 99.6%
Change between Preintervention	Δ	– 16	– 13	– 294	– 8837
and 6-months postintervention[a]	%Δ Pre	– 49%	– 57%	– 79%	– 94%
Change between preintervention	Δ	– 19	– 14	– 301	– 8844
and 12-Months postintervention[a]	%Δ Pre	– 57%	– 60%	– 80%	– 94%
Change between preintervention	Δ	– 21	– 15	– 321	– 8999
and 24-Months Postintervention[a]	%Δ Pre	– 64%	– 64%	– 86%	– 95%
Change between immediate and	Δ	3	– 2	55	565
6-months postintervention	%Δ	21%	– 14%	213%	1629%
	P value	($P = 0.0889$)	($P = 0.0850$)	($P = 0.0001$)	($P = 0.0001$)
Change between 6-months and	Δ	– 3	– 1	– 7	– 7
12-months postintervention	%Δ	– 16%	– 8%	– 9%	– 1%
	P value	($P = 0.0282$)	($P = 0.2760$)	($P = 0.3218$)	($P = 0.9071$)
Change between 12-months and	Δ	– 2	– 1	– 20	– 155
24-months postintervention	%Δ	– 17%	– 9%	– 27%	– 26%
	P value	($P = 0.0307$)	($P = 0.1768$)	($P = 0.0006$)	($P = 0.0030$)
Number of dwellings ($n = 427$)		335	414	401	345

[a] All dust lead loading changes are significant at $P < 0.0001$.

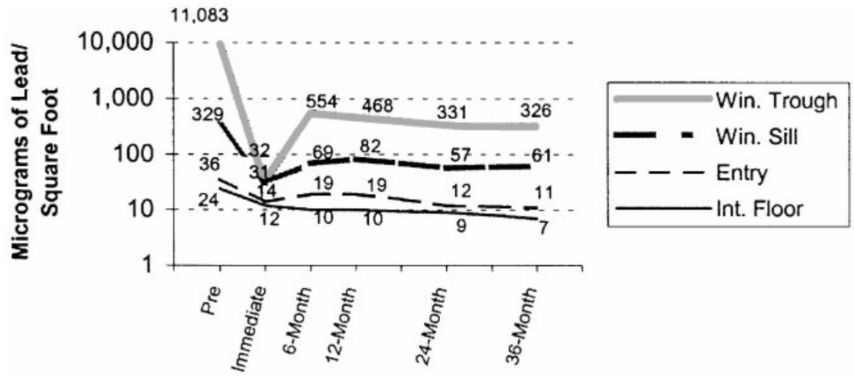

FIG. 1. Change in Geometric Mean Dust Lead Loading at Various Post-Intervention Times by Surface Sampled (36-Month Study Group).

dust lead levels are accompanied by significant reductions in children's blood lead levels 6 and 12 months after intervention. The results suggest that for at least 3 years, the treatments used in the grant program reduced lead exposure for children.

In addition to the significant percentage reductions in dust lead levels, the geometric mean dust lead levels remained below the EPA interim standards (U.S. EPA, 1995). The 24-month entry (11 μg/ft^2) and interior floor dust lead levels (8 μg/ft^2) are 11 and 8%, respectively, of the floor standard of 100 μg/ft^2. The 24-month window sill dust lead level is 11% of the sill standard of 500 μg/ft^2, while the 24-month trough dust lead level is 55% of the trough standard of 800 μg/ft^2. Results for 3-years postintervention indicate similar results.

For dust, it is reasonable to attribute much of the steep decline in the dust lead levels immediately after work to the interventions. It was expected that dust lead levels would reaccumulate from that point as lower level treatments began to fail. While dust lead levels did increase from immediately after interventions to 6 months postintervention, the observed stabilization of levels and declines from that point were unexpected. Neither lead-based paint that remained in the dwellings nor exterior lead-contaminated dust and soil appear to have had a significant impact on dust lead levels for at least 2 to 3 years after intervention.

The purpose of this paper is to examine the overall program and not the effects of the different intensities of treatments. The possibility that some intervention strategies may be less effective than others cannot be precluded. Further study of the individual effects of treatment will be carried out for the final report, with some variation in the effectiveness treatments expected.

The mix of lead hazard control strategies employed by the grantees proved effective when conducted under the auspices of the HUD LHC Grant Program, which required local monitoring of occupant and worker safety and verification of final clearance of the dwellings. Unlike other studies (Farfel and Chisolm, 1990; Amitai *et al.*, 1991), average children's blood lead concentrations did not display an increase immediately after intervention. Demonstrating that the treatments would have the same effects in a less monitored climate would require additional studies.

The increase in dust lead loadings between immediate postintervention and 6 months postintervention followed by a stabilization in levels was similar to the findings in the Baltimore Repair and Maintenance (R&M) Study (Farfel *et al.*, 1998). In that study, samples were collected within 2 months after the intervention and significant increases in dust lead loadings were identified at that point. It was hypothesized in the R&M study that the early reaccumulation was due in part to possible importation of leaded dust during move-in. The HUD LHC Grant Program found increases at

TABLE 5

Change in Geometric Mean Blood Lead Level of Children from Preintervention to Various Postintervention Times ($n = 240$)

Phase		Blood lead (μg/dL)
Preintervention blood lead		11.0
Change at immediate	Δ	− 0.4
postintervention[a]	%Δ Pre	− 3%
Change at 6-months	Δ	− 1.7
postintervention[a]	%Δ Pre	− 16%
Change at 12-months	Δ	− 2.8
postintervention[a]	%Δ Pre	− 26%

[a] All blood lead changes are significant at $P < 0.0001$ (corrected for child's age).

6 months on entry floors and window components but not on interior floors, offering evidence that the immediate increase in leaded dust may be from external sources.

Previous research has suggested that the efficacy of lead hazard control work on reducing blood lead concentrations varies by the baseline blood lead level (Lanphear, 1998). Beneficial effects are more likely to be demonstrated with children with higher baseline levels. The magnitude of blood lead reductions for different categories of baseline blood lead levels will be included in future reports.

When compared to previously reported 1-year lead intervention studies, the age-adjusted decline in blood lead concentration 1-year after intervention is similar to or greater than the percentage changes of the more successful intervention programs (Neimuth *et al.*, 1998; Farfel *et al.*, 1998). Some of the observed decline, however, may be attributable to other factors such as the declines that have occurred nationally over the recent decades (Pirkle *et al.*, 1998; Pirkle *et al.*, 1994). However, the national declines (7%/year) are much less than those observed in the evaluation. Statistically significant declines in blood lead levels presented in this paper have been confirmed by other more involved statistical analyses being conducted in preparation of the final report of the evaluation. Findings reported here indicate that interventions, most of which are less than full abatement, are effective in producing blood lead declines at 12 months postintervention of about 2.8 μg/dL (26%) from a preintervention geometric mean of 11.0 μg/dL.

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