Applied Occupational and Environmental Hygiene

ISSN: 1047-322X (Print) 1521-0898 (Online) Journal homepage: https://www.tandfonline.com/loi/uaoh20

Worker Lead Exposures During Renovation of Homes with Lead-Based Paint

Aaron Sussell , Janie Gittleman & Mitchell Singal

To cite this article: Aaron Sussell , Janie Gittleman & Mitchell Singal (1998) Worker Lead Exposures During Renovation of Homes with Lead-Based Paint, Applied Occupational and Environmental Hygiene, 13:11, 770-775, DOI: 10.1080/1047322X.1998.10389148

To link to this article: https://doi.org/10.1080/1047322X.1998.10389148

Worker Lead Exposures During Renovation of Homes with Lead-Based Paint

Aaron Sussell, Janie Gittleman, and Mitchell Singal

National Institute for Occupational Safety and Health, 4676 Columbia Parkway, Cincinnati, Ohio 45226

We evaluated lead exposures among full-time home renovators and part-time volunteers working primarily in pre-1960 homes with lead-based paint. Potentially hazardous lead exposures were measured during two tasks: exterior dry scraping and wet scraping. Maximum exposures were 120 and 63 $\mu g/m^3$, respectively. Exposures during other tasks, including general repair, weatherization, exterior scraping/painting (mostly applying new paint), window replacement, demolition, and plumbing, were low (range: 0.1 to 16 $\mu g/m^3$), as were all 13 full-shift personal exposures [geometric mean (GM) = 3.6 $\mu g/m^3$; range: 0.2 to 12 $\mu g/m^3$]. Blood lead levels for full-time workers ranged up to 17.5 $\mu g/dl$, with a GM of 5.2 $\mu g/dl$; the GM for volunteers was 3.2 $\mu g/dl$. All of the paint samples collected from work surfaces had detectable amounts of lead (GM = 1.05%), with 65 percent (32) of the work surfaces tested having an average lead concentration of >0.5 percent. Paired sampling results indicate that chemical spot test kits, when used by industrial hygienists, are highly sensitive (100% positive) in screening for high levels (≥9%) of lead in painted work surfaces, and somewhat less so (88% positive) for lower lead levels (>0.5%). Mean paint lead concentrations were well correlated with mean worker exposures during renovation, both by house (r = 0.875) and by work surface (r = 0.898). Average surface lead loadings measured on floors in homes undergoing renovation (2045 $\mu g/ft^2$) and in full-time workers' vehicles (GM = 310 $\mu g/ft^2$) were potentially hazardous to young children. SUSSELL, A.; GITTLEMAN, J.; SINGAL, M.: WORKER LEAD EXPOSURES DURING RENOVATION OF HOMES WITH LEAD-BASED PAINT. APPL. OCCUP. ENVIRON. HYG. 13(11):770–775; 1998.

Title X of the Residential Lead-Based Paint Hazard Reduction Act of 1992 directed federal agencies to protect workers and occupants from lead hazards during lead abatement and renovation work in pre-1978 housing.[1] As a result, the Occupational Safety and Health Administration (OSHA) promulgated an interim lead standard in 1993 to increase the protection required for construction workers, especially those in very high risk jobs such as maintaining bridges and other steel structures. However, since little exposure monitoring for home renovators had been done, there was uncertainty about the lead hazards during home renovation. The management of a nonprofit organization requested a National Institute for Occupational Safety and Health (NIOSH) evaluation of worker lead exposures during home renovation in homes with lead-based paint (LBP). The organization provides home repair and weatherization services to low income homeowners in Cincinnati, Ohio, primarily in pre-1960 homes. At the time of the NIOSH study the organization had 95 full-time employees, about 75 of whom were field personnel. The organization also had a program in which community volunteers participated in two annual home repair events a few days per year. A home "paint-a-thon," an event for repainting occupied homes with deteriorated exteriors, was included in this study. Figure 1 shows a typical activity which took place during this event: exterior dry scraping. The organization had a safety manager and provided training in safe work practices and lead hazards to its full-time employees; volunteers were not provided training.

The primary purpose of the NIOSH study was to characterize worker lead exposures during home renovation in homes with LBP. Secondary objectives were to: (1) determine the concentrations of lead in painted surfaces, (2) evaluate the usefulness of chemical spot test kits for screening for lead in paint, (3) determine the correlation (if any) between paint lead concentrations and worker air lead exposures, and (4) determine the potential for lead exposures among occupant and workers' families from surface lead contamination.

The field study was conducted in 1993 and 1994. The results of this study were initially presented in 1995 at the American Industrial Hygiene Conference and Exposition, Kansas City, Missouri, and at the Lead Tech '95 Conference and Exhibition, Arlington, Virginia.

Methods

All of the home renovation tasks performed by the organization were initially reviewed and categorized with respect to the potential for worker lead exposure. Activities selected for environmental monitoring were those expected to have the highest potential for lead exposures due to disturbance of lead-containing paint or plumbing. Figures 2 and 3 show selected activities, manual demolition and general repair, respectively.

All employees, and volunteers who worked a few days in an annual paint-a-thon, were invited to participate in the evaluation. We observed work practices and measured the lead exposures of both full-time home renovators and part-time volunteers at 18 Cincinnati homes. A self-administered questionnaire was used to collect information about the workers' work histories, hygiene practices, and potential lead-related symptoms. Blood samples were collected for tests of blood lead level (BLL), zinc protoporphyrin, hemoglobin, hematocrit, erythrocyte count and indices, creatinine, urea nitrogen, and uric acid. Informed written consent was obtained from all participants.

Personal breathing zone and area air samples, surface wipes,

FIGURE 1. Worker dry scraping exterior paint during home painting event.

and bulk paint chip samples were collected during renovation projects. The personal air monitoring included both full-shift and task-based sampling, with emphasis on the latter; sampling

FIGURE 2. Workers manually demolishing a deteriorated plaster ceiling.

FIGURE 3. Workers repairing a painted porch floor.

periods (range: 12 to 504 minutes) sometimes included on-site work breaks. Area air samples were located in areas representative of the exposures of nearby workers and bystanders. Air samples were collected at the rate of 2.0 L/min with personal sampling pumps that had been calibrated immediately before sampling. Air samples were prepared and analyzed by NIOSH Method 7082 (flame atomic absorption spectrophotometry), and if no lead was detected, the samples were subsequently analyzed by NIOSH Method 7105 (graphite furnace atomic absorption spectrophotometry), which can detect quantities of lead about two orders of magnitude lower than Method 7082.[2] When no lead was detected in an environmental sample, one half the respective limit of detection (LOD) was used to calculate a numerical value.[3] These estimated lead concentrations were used in the data analyses.

Blood lead analyses were performed at the Centers for Disease Control and Prevention's National Center for Environmental Health by graphite furnace atomic absorption.[4] The other tests were done by a commercial laboratory.

Paint chip samples were collected at 15 of the 18 homes evaluated. One to six samples per surface were collected by donning clean vinyl gloves and using a stainless steel paint scraper to remove approximately 2 × 2 cm of the paint layers to bare wood. The paint chip samples were stored in sealable plastic bags or glass vials. Samples were analyzed for percent lead by weight using NIOSH Method 7082, modified for microwave digestion of paint.[2] In cases where multiple paint chip samples were collected for a work surface, the mean value was used for data analyses. Field chemical spot tests for lead (Lead Check™ Swabs, HybriVet Systems, Inc., Natick, Massachusetts) were performed on 41 painted surfaces immediately adjacent to the surfaces from which paint chip samples were collected. The participating NIOSH industrial hygienists were instructed to expose all paint layers on the substrates by making a V-shaped cut with a stainless steel knife before applying the spot test solution.

Surface wipe samples were collected in renovated homes and in workers' vehicles during renovation. Hard-surface floors and window wells were sampled in homes. Samples were collected from the center of the driver's side floor in vehicles owned by 20 full-time workers and 11 part-time volunteers. For ease of sampling, we used the wipe method for

TABLE 1. Task-Based Personal Air Sampling Results

Task	No. of Samples	Lead Concentration ($\mu g/m^3$) GM	Range
Dry scraping (exterior)	15	9.1	0.2–120
Wet scraping (exterior)	7	6.7	0.7–63
Demolition	4	6.0	3.5–11
Window replacement	8	5.6	2–16
Plumbing	6	1.5	0.04[A]–11
Other[B]	11	0.4	0.03[A]–2.7
General repair	10	0.5	0.1[A]–4.7
Scraping/painting (exterior)	9	0.4	0.04[A]–14
Weatherization	7	0.2	0.05[A]–2.1
Total	77		

[A]None detected results for which one half the LOD was used to calculate numerical values.
[B]Drilling holes, power washing, sweeping, sawing boards.

sampling all vehicle floor surfaces, including both carpets and rubber mats. We considered, but did not use, an alternative microvacuum method to sample dust on carpets. Recently the results of the two dust sampling methods have been found to be statistically correlated.[5] Wipe samples were collected and analyzed according to NIOSH Method 9100.[2] All samples were collected with premoistened towelettes (Wash'n Dri®, Softsoap Enterprises, Inc., Chaksa, Minnesota), which have been found to be free of lead contamination and result in good analytical recoveries of lead dust.[6] Disposable sampling templates cut from 8.5 × 11-inch plastic transparencies were used to define 10 × 10-cm surface areas for sampling; a new template was used for each sample.

Results

Results of 77 task-based personal air samples are summarized in Table 1. Potentially hazardous lead exposures were measured during exterior dry scraping and wet scraping of LBP, with maximum exposures of 120 and 63 $\mu g/m^3$, respectively. The geometric means (GMs) for exposures during exterior dry and wet scraping tasks were low: 9.1 and 6.7 $\mu g/m^3$. Exposures during all the other tasks, including general repair, weatherization, exterior scraping/painting (mostly applying new paint), window replacement, demolition, and plumbing, were low (range: 0.03 to 16 $\mu g/m^3$). Results for 13 full-shift (greater than 360 minutes) personal samples, which included break periods, initial setup, and cleanup, were low (GM = 3.2 $\mu g/m^3$; range: 0.05 to 12 $\mu g/m^3$; see Table 2). Results for 37 area air samples were lower than the corresponding personal sample results for each task (overall GM = 0.6; range: 0.1 to 25 $\mu g/m^3$); the highest was during exterior dry scraping of LBP.

Sixty-eight (72%) of the full-time employees participated in the medical evaluation. On the basis of their questionnaire responses, we determined that 47 (63%) of the participants were field personnel. Fifty-three employees, 39 of whom were field personnel, had a blood lead test. Ten persons, all field personnel, had a BLL of 10 $\mu g/dl$ or greater. This represents 19 percent of all tested employees and 26 percent of the field personnel. Four employees (8% of all tested employees, 10% of field personnel) had BLLs of 15 $\mu g/dl$ or greater; the highest was 17.5 $\mu g/dl$. GM BLL for all full-time workers tested was 5.2 $\mu g/dl$; of these employees, the GM was 6.3 $\mu g/dl$ for field personnel and 2.7 $\mu g/dl$ for office personnel. The distribution of BLLs indicates that the field workers had somewhat more lead exposure than the general U.S. adult population (<7% with BLLs ≥ 10 $\mu g/dl$, <2% with ≥ 15 $\mu g/dl$, and GM <4 $\mu g/dl$),[7] but none of the BLLs exceeded any current occupational exposure criterion. Since none of the BLLs were in the range that would account for either symptoms or abnormalities in the other blood tests, neither the results of those tests nor the questionnaires were analyzed for this report.

Thirty-three paint-a-thon volunteers participated in the evaluation. We offered both preshift and postshift blood lead testing to the volunteers because we thought it was possible, since they were not provided respirators by the organization, that they could receive enough exposure to show an increase over the workday. Fourteen volunteers participated in both preshift and postshift testing, and six others who missed the preshift testing were tested during the shift. Cross-shift change in BLL ranged from a decrease of 3.5 $\mu g/dl$ to an increase of 5.3 $\mu g/dl$. The mean change was +0.4 $\mu g/dl$, which is not

TABLE 2. Full-Shift Personal Air Sampling Results

Job Title	Primary Task	Time (min)	Lead Concentration ($\mu g/m^3$)
Volunteer	Wet scraping (exterior)	504	0.9
Volunteer	Wet scraping (exterior)	502	3.3
Repair technician	Demolition	465	3.7
Volunteer	Scraping (exterior)	437	10.0
Volunteer	Scraping/painting (exterior)	417	12.0
Volunteer	Scraping (exterior)	412	1.5
Generalist 2	Demolition	411	11.1
Volunteer	Scraping/painting (exterior)	411	4.3
Crew leader	Demolition	409	9.0
Installer	Weatherization	407	0.05[A]
Repair technician	Demolition	390	3.5
Volunteer	Scraping (exterior)	386	2.0
Volunteer	Wet scraping (exterior)	361	12.0

[A]None detected result for which one half the LOD was used to calculate numerical value.

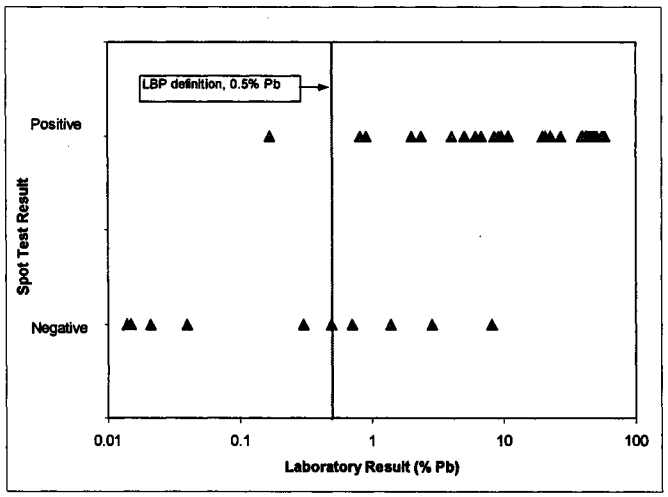

FIGURE 4. Spot test versus laboratory results for paint lead.

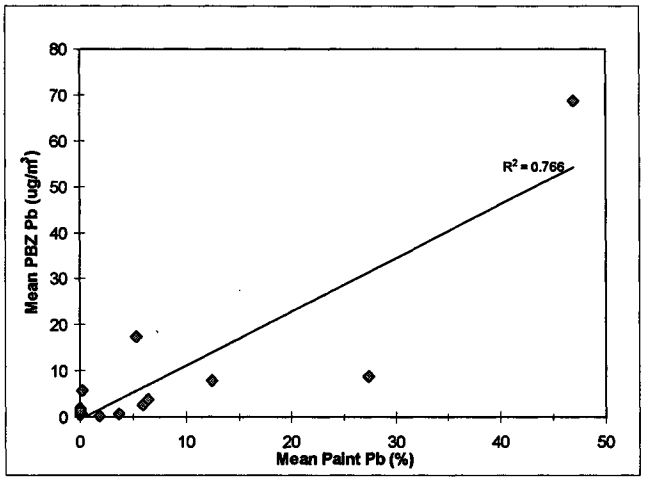

FIGURE 5. Correlation between surface and air lead for 15 houses.

significantly different from zero ($t = 0.59$, $p > 0.5$). The largest change was from 18.8 to 24.1 μg/dl. This occurred in a person whose current occupation (at the time of the survey) and history of volunteer work for the organization could not be ascertained from his questionnaire because of incomplete and contradictory information. The other 19 volunteers tested had BLLs (using the highest where there were two) that ranged from 1.6 to 13.7 μg/dl, with all but one being less than 10 μg/dl. The GM BLL among the 20 volunteers (using the average value if there were both preshift and postshift results) was 3.2 μg/dl. Thus, although one volunteer had an elevated (by general population standards) BLL, the overall distribution of the volunteers' BLLs was consistent with that of the general U.S. adult population, and there was no cross-shift pattern demonstrating substantial worksite exposure to lead.

A total of 126 paint chip samples were collected from 49 painted work surfaces in 15 homes; all had detectable amounts of lead (GM = 1.05; range: 0.0022 to 58% lead). Sixty-five percent (32) of the work surfaces tested had an average lead concentration of ≥0.5 percent. Chemical spot tests on immediately adjacent areas were performed for 41 (84%) of these work surfaces; the results (positive or negative) are compared to the average paint lead concentrations obtained by laboratory analysis in Figure 4. Spot test results were 100 percent positive (22 of 22) for surfaces with ≥9 percent lead and 88 percent positive (30 of 34) for surfaces with >0.5% lead. One of seven samples with results <0.5 percent lead had a positive spot test result. Mean paint lead concentrations were well correlated with mean worker exposures by house ($R^2 = 0.766$; see Figure 5) and by work surface ($R^2 = 0.794$; see Figure 6).

Results for wipe samples are presented in Table 3. Twelve surface dust samples, collected on floors in six homes during renovation, on average had high lead loadings (average for floor samples = 2045 μg/ft²), and both window wells sampled had very high loadings (69,000 and 120,000 μg/ft²). According to the criteria of the U.S. Department of Housing and Urban Development (HUD), these surface lead levels were a lead hazard to occupant children.[8] Young children were present in the homes undergoing renovation, but the number potentially exposed to surface lead contamination was not determined. Lead levels in full-time workers' vehicles (average = 310 μg/ft²) were higher than those in volunteers' vehicles (average = 140 μg/ft²), although the difference narrowly missed statistical significance ($p = 0.06$, Student's *t*-test, one tail).

Discussion

This study indicated that workers renovating pre-1960 Cincinnati homes have a high risk of encountering LBP. The majority of the painted work surfaces measured had lead concentrations greater than the federal definition of LBP (0.5% lead), and all of the work surfaces tested had detectable amounts of lead, a condition that triggers the requirements of the OSHA construction lead standard. These results are consistent with a HUD national survey, which found that 74 percent of housing built before 1980 has LBP somewhere in the building.[9]

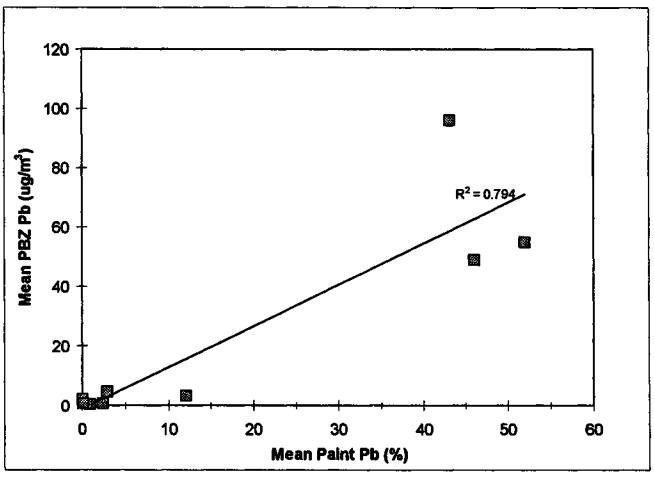

FIGURE 6. Correlation between surface and air lead for ten work surfaces.

TABLE 3. Surface Sampling Results for Vehicles and Homes

Surfaces Sampled	No. of Samples	Lead Concentration ($\mu g/ft^2$) Mean	Range
Floors in volunteers' vehicles	11	140	5[A]–490
Floors in workers' vehicles	20	310	4[A]–1900
Floors in homes[B]	12	2045	14[A]–14,000
Window wells in homes[B]	2	—	69,000–120,000

[A]None detected results for which one half the LOD was used to calculate numerical values.
[B]Samples collected during renovation work.

This study suggests that although the organizations' workers generally have low lead exposures during home renovation tasks, both exterior wet scraping (surfaces are misted with water during scraping) and dry scraping are potentially hazardous. The exterior paint scraping was performed only by part-time volunteers, so we could not determine if the full-time workers would have had similar exposures for these tasks. However, a recent study found similar average exposures among workers performing exterior surface preparation activities, and much higher exposures during interior surface preparation.[10] After the results were obtained, we informed the organization that surface preparation work performed by volunteers was potentially hazardous and recommended that volunteers be provided training on lead hazards and proper hygiene practices, as well as appropriate respirators and protective work coveralls. Based on this information, the management decided to discontinue home painting in their volunteer program. Lead exposures measured during other home renovation tasks, including sweeping debris, power washing, drilling, general repair, demolition, plumbing, and window replacement, were low, but the study size was inadequate to conclude that hazardous exposures could never occur during these tasks. Blood lead testing indicated some occupational lead exposure among full-time workers, but their BLLs were below current occupational exposure criteria. Prior to the study, we considered the possibility that volunteers who were not ordinarily occupationally exposed to lead might receive sufficient exposure after only 1 day to show an increase in BLL. This, however, proved not to be the case; overall, their lead exposures were relatively low. (The reason for the relatively high preshift BLL in one volunteer was not determined.)

Worker lead exposures in the group studied were mitigated by three factors: (1) all paint scraping was on building exteriors; (2) paint scraping was performed very infrequently; and (3) no abrasive power tools were used to remove LBP. In buildings with LBP, interior scraping and paint removal with abrasive power tools or heat guns generate substantial amounts of lead-containing dust.[11,12] However, the worker exposures NIOSH has measured during lead abatement work are generally similar to those measured for this group of home renovators.[12]

Paint lead levels appeared to be correlated with worker lead exposures, both by house and by work surface. However, the results should be interpreted with caution. In contrast to the results here, two previous NIOSH studies of worker exposures during residential LBP abatement found only very weak correlations between paint lead concentrations and personal lead exposures.[11,12] In this study, the correlation may appear stronger than it really is because of the regression line being anchored by data points at the ends of the distribution. For example, the correlation coefficient (R^2) for the data in Figure 5 is 0.766; without the highest data point the coefficient drops to 0.241. In both cases (Figures 5 and 6), there are relatively few data points in the middle concentration ranges.

This study showed that chemical spot test kits, when used by industrial hygienists, are highly sensitive in screening for high levels (≥9%) of lead in painted work surfaces. However, a previous NIOSH study found that potentially hazardous worker exposures can occur during paint scraping indoors even when average paint lead levels are less than 0.5 percent lead.[11] NIOSH currently recommends quantitative laboratory or field analysis for accurately determining lead concentrations in paint.

Average surface lead levels measured in homes undergoing renovation and in full-time workers' vehicles were potentially hazardous to young children. Lead contamination in the workers' vehicles may have resulted from ineffective hygiene practices at the work sites. Contamination tracked into workers' cars or homes can pose a potential threat to workers' young children, as shown by a NIOSH study of New Jersey construction workers, which found that children of lead-exposed construction workers are more likely to have elevated BLLs than those of neighbor children.[13]

Home renovation and remodeling can also put occupant children at risk for childhood lead poisoning.[14] Since this study did not determine if the surface lead levels in homes were preexisting or if they were caused by the ongoing renovation work, no conclusions can be drawn about the increased risk to occupant children during or following remodeling. Further study is needed to better assess the prevalence and degree of childhood lead exposure caused by renovation and remodeling work in homes with LBP.

Recommendations

The following recommendations were offered to assist the organization in protecting workers and occupants during renovation in homes with LBP:

1. Due to the relatively high prevalence of LBP in homes built before 1978, painted surfaces should be assumed to contain LBP unless quantitative analysis shows otherwise.
2. To protect themselves, occupants, and their own families, renovators working in homes with LBP should follow the requirements and recommendations of OSHA, HUD, and the U.S. Environmental Protection Agency for safe work practices in residences with LBP, including (1) isolating

areas where work is performed from other areas of the house; (2) prohibiting occupants and bystanders from entering the work area; and (3) performing specialized daily and final cleanup of work areas and tools.[8,15]

3. A high efficiency particulate air (HEPA) vacuum should be available for cleaning at all job sites where paint is disturbed. Additionally, for these jobs workers should be expected to wear disposable shoe covers which are left on site, or clean off their shoes before leaving the site using disposable wipes (baby wipes). Workers should be instructed to clean their personal vehicles regularly with HEPA vacuums.
4. The organization should send some field personnel to state-certified training courses required for lead abatement workers and supervisors to learn about safe work practices for worker and occupant protection.
5. The organization should provide additional training and protective measures to all volunteers who will be scraping paint, even though their exposures on average were relatively low. The volunteers should be provided appropriate respirators, coveralls, and a brief training session at the beginning of each day they volunteer. The training should include information about health effects of lead exposure, approved work practices, and hygiene practices to prevent ingestion or take-home of lead contamination. These precautions should protect all volunteers, including pregnant and breastfeeding women. (After receiving our interim report and discussing the volunteers' exposures, the organization decided to discontinue home painting by volunteers.)

Acknowledgments

The authors acknowledge and thank Stefan Olson and Kathleen Hope Curry from the home repair organization for their assistance in initiating and completing this project. This field study would not have been possible without the many NIOSH personnel involved. We are grateful for industrial hygiene and medical assistance provided by Maria Abundo, Abdul Azad, Kevin Ashley, Bruce Bernard, Nancy Burton, Calvin Cook, Eric Esswein, Lynda Ewers, Charles Hayden, Ann Krake, David Marlow, Susan McFarland, Leroy Mickelsen, Aubrey Miller, Gregory Piacitelli, Beth Reh, Donna Spontak, and Samuel Waltzer. Ellen Blythe was especially helpful in preparing this manuscript.

Disclaimer

Mention of trade names, commercial products, or organizations does not imply endorsement by the U.S. government.

References

1. Residential Lead-Based Paint Hazard Reduction Act of 1992. Public Law 102-550 from U.S. House Report 102-1017 (October 28, 1992).
2. National Institute for Occupational Safety and Health: NIOSH Manual of Analytical Methods, 4th ed. DHHS (NIOSH) Pub. No. 94-113. NIOSH, Cincinnati, OH (1994).
3. Hornung, R.W.; Reed, L.D.: Estimation of Average Concentration in the Presence of Nondetectable Values. Appl. Occup. Environ. Hyg. 5:46–51 (1990).
4. Miller, D.T.; Paschal, D.C.; Gunter, E.W.; et al.: Determination of Lead in Blood Using Electrothermal Atomisation Atomic Absorption Spectrometry with a L'vov Platform and Matrix Modifier. Analyst 112:1701–1704 (1987).
5. Clark, S.; Bornschein, R.L.; Pan, W.; et al.: An Examination of the Relationships Between the U.S. Department of Housing and Urban Development Floor Lead Loading Clearance Level for Lead-Based Paint Abatement, Surface Dust Lead by a Vacuum Collection Method, and Pediatric Blood Lead. Appl. Occup. Environ. Hyg. 10:107–110 (1995).
6. Millson, M.; Eller, P.; Ashley, K.: Evaluation of Wipe Sampling Materials for Lead in Surface Dust. Am. Ind. Hyg. Assoc. J. 55:339–342 (1994).
7. Pirkle, J.L.; Brody, D.J.; Gunter, E.W.; et al.: The Decline in Blood Lead Levels in the United States. JAMA 272:284–291 (1994).
8. U.S. Department of Housing and Urban Development: Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing. HUD, Washington, DC (1995).
9. U.S. Department of Housing and Urban Development: Comprehensive and Workable Plan for the Abatement of Lead-Based Paint in Privately Owned Housing: Report to Congress. Pub. No. HUD-PDR-1295. HUD, Washington, DC (1990).
10. U.S. Environmental Protection Agency: Lead Exposure Associated with Renovation and Remodeling Activities: Summary Report. EPA Pub. No. EPA 747-R-96-005. EPA, Washington, DC. (1997)
11. National Institute for Occupational Safety and Health: Hazard Evaluation and Technical Assistance Report, Ohio University. NIOSH Report No. HETA 92-095-2317. NIOSH, Cincinnati, OH (1993).
12. National Institute for Occupational Safety and Health: Hazard Evaluation and Technical Assistance Report, HUD Lead-Based Paint Abatement Demonstration Project. NIOSH Report No. HETA 90-070-2181. NIOSH, Cincinnati, OH (1992).
13. Piacitelli, G.M.; Whelan, E.A.; Sieber, W.K.; et al.: Elevated Lead Contamination in Homes of Construction Workers. Am. Ind. Hyg. Assoc. 58:447–454 (1997).
14. Centers for Disease Control and Prevention: Children with Elevated Blood Lead Levels Attributed to Home Renovation and Remodeling Activities–New York, 1993–1994. MMWR 45: 1120–1123 (1997).
15. U.S. Environmental Protection Agency: Reducing Lead Hazards When Remodeling Your Home. Pub. No. EPA 747-R-94-002. EPA, Washington, DC (1994).