



An investigation into porch dust lead levels

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ARTICLE INFO

Article history:

Received 25 August 2014

Received in revised form

16 November 2014

Accepted 25 November 2014

Keywords:

Lead

House dust

Porch

Intervention

Exposure

ABSTRACT

Lead in porch dust can expose children through direct contact or track-in to the home, but has not been adequately evaluated. At homes undergoing lead hazard control in Rochester, NY, we sampled settled dust lead on exterior porch floors at baseline, immediately post-lead hazard control and one-year post-work ($n = 79$ homes with complete data) via wipe sampling and collected housing, neighborhood and soil data. Baseline GM porch floor dust lead loading (PbPD) was $68 \mu\text{g}/\text{ft}^2$, almost four times more than baseline GM interior floor dust lead ($18 \mu\text{g}/\text{ft}^2$). Immediate post-work PbPD declined 55% after porch floor replacement and 53% after porch floor paint stabilization ($p = 0.009$ and $p = 0.041$, respectively). When no porch floor work was conducted but lead hazard control was conducted elsewhere, immediate post-work PbPD increased 97% ($p = 0.008$). At one-year, GM PbPD continued to decline for porch replacement (77% below baseline) and paint stabilization (72% below baseline), but where no porch floor work was done, GM PbPD was not significantly different than baseline ($p < 0.001$, $p = 0.028$ and $p = 0.504$, respectively). Modeling determined that porch floor replacement had significantly lower one-year PbPD than stabilization when baseline PbPD levels were higher than $148 \mu\text{g}/\text{ft}^2$ (the 77th percentile) but not at lower levels. Treatment of porches with lead paint results in substantial declines in PbPD levels. It is of concern that PbPD levels increased significantly at immediate post-work when lead hazard control was not conducted on the porch but was conducted elsewhere. Standards for porch lead dust should be adopted to protect children from inadequate clean-up after lead hazard control.

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1. Introduction

Children who live in homes with elevated levels of dust lead are at risk of exposure to lead, a neurotoxin that can result in significant cognitive impacts and other adverse health effects (Lidsky 2003; Lanphear et al., 2005). Lead in settled housedust has been well documented as a pathway of lead into the bodies of young children (Bornschein et al., 1985; Lanphear and Roghmann 1997; Lanphear et al., 1998; Dixon et al., 2009). In 2001, USEPA established health-based standards for interior dust lead levels to protect children (US EPA, 2001). Previous studies have documented that exterior dust lead can enter homes through track-in

and blow-in, contributing to the levels on interior floors and window surfaces (Adgate et al., 1998; Clark et al., 2004; Dixon et al., 2007). Additionally, children who play on porches may be at risk from direct exposure to porch dust lead. However, standards for exterior lead dust on porches or other exterior surfaces have not been developed.

The Evaluation of the HUD Lead Control Grant Program found that dwellings without exterior treatments had interior dust lead levels that were 33% higher than dwellings where exteriors were treated (Dixon et al., 2005). For a dwelling that is part of the Federally-assisted housing program and which has a porch, the exterior of the building could be treated to be in full compliance with all surfaces made lead-safe, but currently there is no way to adequately determine the degree of risk associated with porch floor dust lead loadings. The 1995 HUD Guidelines recommended that buildings undergoing exterior hazard control have an exterior clearance (post-clean up) dust wipe collected “on a horizontal surface in part of the outdoor living area (e.g., a porch floor or entryway)” (HUD, 1995) and recommended an exterior clearance level of $800 \mu\text{g}/\text{ft}^2$. In subsequent rulemaking, neither HUD nor EPA has required clearance wipe sampling on exterior surfaces, except for window troughs. However, window troughs cannot

Abbreviations: $\mu\text{g}/\text{ft}^2$, micrograms of lead dust per square foot of surface area; mg/cm^2 , milligrams of lead paint per square centimeter of surface area; GM, Geometric mean; HUD, U.S. Department of Housing and Urban Development; PbPD, Porch floor dust lead loading ($\mu\text{g}/\text{ft}^2$)

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serve as a surrogate for porch floors and their potential to be a source of tracked-in dust. In its decision not to establish an exterior dust lead standard, EPA stated that “With respect to dust on external surfaces, EPA is concerned that the extent of the data linking it to health effects beyond the sources already identified is limited.” (US EPA, 2000).

This study was undertaken to fill this gap in understanding and to help inform decision-making about the significance of an appropriate response to porch dust lead. A porch dust lead guidance level could be a valuable measure of the adequacy of clean-up after exterior lead hazard control work. It would also serve as a useful marker of exterior risk, particularly for children who spend time playing on porches. Finally, it could prevent exterior hazards from increasing interior hazards through tracked-in dust lead.

Several previous studies collected dust lead samples from porches, but the analysis of these data have been very limited. The 1994 Rochester Lead-In-Dust Study collected 125 exterior porch wipe samples, along with blood lead levels of a child residing in each of those homes (Lanphear, 1995). Based on that study data, we found that blood lead was significantly correlated with porch mid-point floor loading (Spearman's $r=0.29$ with $p=0.001$). Other studies have also collected dust lead samples from porches (e.g., the Sixth Year Analysis of the Evaluation (Wilson et al., 2006)), but the protocols for these studies frequently have allowed for sampling of other surfaces as a general exterior sample, including steps, sidewalks, and patios. In 2002–03, the Milwaukee Health Department collected porch dust lead samples from dwellings enrolled in HUD's Milwaukee Ordinance Study. The study found that in this set of homes, dust lead levels immediately outside of the entry of a home are on average more than 2.5 times the interior floor dust lead standard and at one location, the level was over 150 times the interior standard (National Center for Healthy Housing, 2004).

Rochester was selected for this study because it has a housing stock with many exterior unenclosed porches and has a well-documented history of lead hazards and lead-poisoned children. In a 2012–2013 Monroe County Health Department pilot program, 98% of 51 single family structures in Rochester cited for lead hazards had lead paint hazards on the porches (Monroe County Department of Public Health, 2013). The researchers partnered with the City of Rochester Lead Hazard Control Program to examine exterior porch dust lead levels at homes receiving interior and in many cases, exterior treatment. This allowed the study to document baseline (pre-work) porch dust lead levels and the effect of interior and exterior interventions on those porch dust lead levels. The relationship between porch floor dust lead loading ($\mu\text{g}/\text{ft}^2$) (PbPD) and interior floor and window sill dust lead levels are also examined.

2. Methods

We enrolled 102 dwellings with unenclosed painted porches > 20 square feet that were scheduled to have lead hazards addressed by the City of Rochester's HUD-funded Lead Hazard Control grant program. The porch did not have to serve as the primary entry to the residence. A convenience sample of 32 respondents reported that 69% of residents used the porch entrance daily and another 22% used it at least weekly. Only 9% used the porch entrance rarely or never.

Certified lead risk assessors collected data on visual condition of paint, dust and soil lead levels using EPA protocols (24 CFR Part 745), condition and cleanliness of the porch, the type and condition of floor surfaces, the weather conditions, soil coverage, and presence of other lead point sources in the neighborhood during the three phases of the study (before intervention, immediately

Table 1

Number of dwellings with PbPD results by floor treatment.

Floor treatment	Number of dwellings with PbPD samples available by phase			
	Baseline	Baseline and one-year	Baseline and clearance	Baseline, clearance and one-year
Dropped before treatment	10	0	0	0
Replace/remove	54	50	49	45
Paint stabilization	8	8	7	7
None	30	30	27	27
All	102	88	83	79

after work was completed, and again one year post-work). The local lead hazard control program determined if porches should be treated or not. Out of the enrolled homes, 92 underwent lead hazard control. The risk assessors sampled porch dust within one month of being notified that the lead hazard control program had assessed and cleared the work. Some pot-work assessments were missed because of inclement weather or communication errors (Table 1). Porch dust samples were available from all three phases at 79 dwellings.

Dust wipe samples were collected from three locations on each porch floor: next to the front entry (entry sample); next to the step or stairs leading to the porch (step sample); and next to a railing away from the entry (railing sample) using the standard HUD method (Fig. 1 – Xs) (HUD, 1995). Dust samples were analyzed for lead using ASTM Method 1644-04 and ASTM Method E1613 or Inductively Coupled Plasma Atomic Emission Spectrometry. Testing laboratories participated in EPA's National Lead Laboratory Accreditation program. Baseline dust wipe samples were also collected by city funded contractors from window sills and non-entryway floors from inside the structure as part of a risk assessment conducted according to the HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing (HUD, 1995).

2.1. Longitudinal PbPD

At 13 of the treated study dwellings selected by convenience, lead dust loading was measured during an additional 16 points in time starting after completion of work and continuing for one year after treatment to assess dust lead loading levels over time. The study collected dust lead on settling plates twice a month for the



Fig. 1. Typical exterior porch in Rochester, New York (X=dust wipe sampling locations; square=location of dust collection plate).

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