Evaluation of a Visual Assessment Tool for Identifying Homes with Elevated Lead Concentrations in Soil

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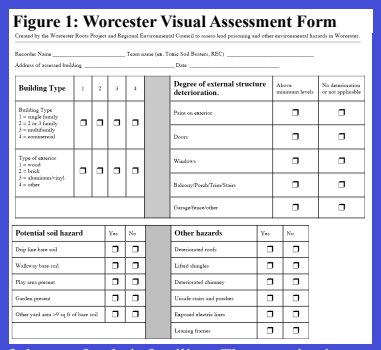
INTRODUCTION

The U.S. government banned the use of lead-based paints for houses built after 1978. However, lead stills remains on many old homes and fixtures that were once covered with now-banned lead paint. Studies have found that approximately 24 million houses in the United States have deteriorating lead paint and that one or more children live in 4 million of these contaminated homes, resulting in adverse health effects for their growing bodies (CDC 2009). For those planning on gardening or using their yards as a play area for young children, residual lead in the form of paint chips and lead dust poses a threat to their own and, more importantly, to their children's health.

Lead is toxic to various tissues and organs such as the heart, kidneys, bones and reproductive and nervous systems (WHO 1995). The length of time of the exposure in addition to the amount of lead in the tissues and blood determines the toxicity (Hu 2007). Whenever the bones release calcium during pregnancy and breast-feeding, the lead filters into the blood, which causes potential damage to the fetus's central nervous system (Szabo 2007). Health problems of children with high blood lead levels include headaches, hearing problems, slow growth, learning disabilities, behavioral problems, seizures, and death (EPA 2010). Studies have also shown that babies of mothers with high lead levels are typically smaller and receive lower test scores on mental development exams at age two (Szabo 2007). Adults experience similar health effects as children but have a much higher threshold.

In Worcester, Massachusetts, community members have begun to remediate homes across the city in an effort to reduce child exposure to lead. Worcester Roots is an organization that tackles this environmental justice issue through organizing the community to ensure safe homes for their families. The organization uses a Visual Assessment tool as the first step in their protocol (Figure 1). The tool is used to identify areas that are most likely to be at risk of lead contamination. Once high-risk areas are identified, Worcester Roots proceeds with their soil sampling and remediation protocols. The objectives of this study were to evaluate the internal validity of the Visual Assessement tool and to determine how well the tool can be used to predict measured soil lead concentrations.

Figure 1: Worcester Visual Assessment Form



Created by the Worcester Roots Project and Regional Environmental Council to assess lead poisoning and other environmental hazards in Worcester.

Recorder Name _____ Team name (ex. Toxic Soil Busters, REC) _____

Address of assessed building _____ Date _____

Building Type	1	2	3	4
Building Type 1 = single family 2 = 2 or 3 family 3 = multifamily 4 = commercial	❒	❒	❒	❒
Type of exterior 1 = wood 2 = brick 3 = aluminum/vinyl 4 = other	❒	❒	❒	❒

Degree of external structure deterioration.	Above minimum levels	No deterioration or not applicable
Paint on exterior	❒	❒
Doors	❒	❒
Windows	❒	❒
Balcony/Porch/Trim/Stairs	❒	❒
Garage/fence/other	❒	❒

Potential soil hazard	Yes	No
Drip line bare soil	❒	❒
Walkway bare soil	❒	❒
Play area present	❒	❒
Garden present	❒	❒
Other yard area >9 sq ft of bare soil	❒	❒

Other hazards	Yes	No
Deteriorated roofs	❒	❒
Lifted shingles	❒	❒
Deteriorated chimney	❒	❒
Unsafe stairs and porches	❒	❒
Exposed electric lines	❒	❒
Leaning frames	❒	❒

METHODS

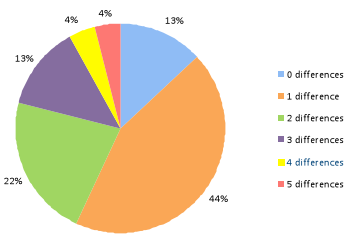
Visual assessment is a tool for predicting lead contamination in the soil based on the conditions of the house. The visual assessment tool requires the user to observe and record conditions of the roof, windows, doors, porch, garages, fence, as well as walls. We focused our attention particularly on potential paint chipping as this is the greatest cause for soil contamination.

To evaluate the internal validity of the visual assessment tool, two teams independently evaluated the same homes using the tool. Inter-rater agreement was calculated using Cohen's kappa statistic. To evaluate the tool's ability to predict soil lead concentrations, we compared the visual assessment scores to soil lead concentrations in a subset of homes that had been previously been tested for lead content in soil.

RESULTS

The visual assessment form requires each rater to score 17 house characteristics. Results from the visual assessment scores indicate that the majority of assessments (79%) had fewer than three disparities between the raters (Figure 2).

Figure 2: Comparison of Visual Assessment Results
(within the Visual Assessment Form, there are 17 siginificant house characteristics, including degree of external structure deterioration; potential soil hazard, as well as other hazards -- a total number



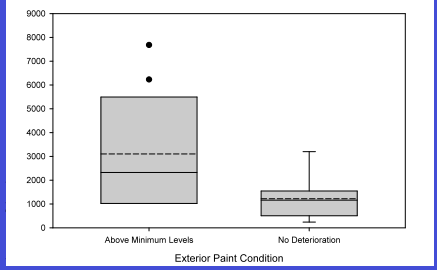
Inter-rater reliability was also examined on a question by question basis, for two scenarios – Brandeis students against Brandeis students, and Brandeis students against Worcester Roots youth. The results show very strong inter-rater agreement (kappa = 0.8 – 1.0) for the 14 of the 17 questions (Table 1). For the Brandeis v. Brandeis comparison, only two questions – degree of external structure deterioration on the balcony/porch/trim/stairs and unsafe stairs/porches – showed moderate agreement (kappa = 0.4 – 0.6). The agreement was largely independent of who performed the rating (ie, similar results for Brandeis v. Brandeis and Brandeis v. Worcester Roots), with discordance observed only for the potential soil hazard in the garden question and unsafe stairs/porch question.

Table 1. Cohen's kappa statistics for each question on the visual assessment form

		Brandeis v. Brandeis	Brandeis v. Worcester Roots
Degree of external structure deterioration	Paint on exterior	0.9	1.0
	Doors	0.9	0.9
	Windows	0.9	0.8
	Balcony/Porch/ Trim/Stairs	0.4	0.4
	Garage/fence/other	0.9	0.8
Potential soil hazard	Drip line bare soil	0.9	0.8
	Walkway bare soil	0.9	1.0
	Play area present	0.9	0.9
	Garden present	0.9	0.5
	Other yard area	1.0	0.9
Other hazards	Deteriorated roofs	1.0	0.9
	Lifted shingles	0.9	1.0
	Deteriorated chimney	0.9	0.9
	Unsafe stairs and porches	0.6	1.0
	Exposed electric lines	1.0	0.9
	Leaning frames	0.9	1.0
	Average kappa	**0.9**	**0.9**

Visual assessment scores recorded in 2010 were generally not associated with pre-remediation soil concentrations. However, the lack of an association may be due to the time interval that elapsed from the pre-remediation sampling and visual assessment (up to five years). There is suggestive evidence that the condition of the exterior paint is predictive of soil lead concentrations (p=0.11) (Figure 3).

Figure 3. Lead concentrations (ppm) in soil by exterior paint condition



CONCLUSIONS

- The visual assessment tool showed strong inter-rater reliability (Mean kappa = 0.9)
- Inter-rater reliability was consistent across groups (Brandeis v. Brandeis; Brandeis v. Worcester Roots)
- The ability of the visual assessment tool in predicting pre-remediation soil concentrations is limited by the time lag in this study
- There is suggestive evidence that some questions may be predictive of soil lead concentrations, even with this time lag