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# Pesticide Residues and Lead: Neurotoxins in the Home Environment

*Research Article*

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## Abstract

**Objectives:** To examine the extent to which pesticide residues and lead-laden dust are present in homes.

**Materials and Methods:** This study used a two-stage random sampling procedure to identify a representative sample of homes in non-metropolitan counties of New York State. A technician visited those homes performed wipe tests that were analyzed for lead and pesticide residues.

**Results:** Dangerously high levels of lead were observed. In addition, residues of all 15 pesticides that were tested for were observed in every home.

**Conclusion:** Educators involved in lead and pesticide education programs may want to include program elements that include home maintenance guidelines for prevention and safe eradication of accumulated lead and pesticide residues of which consumers may not be aware. This could be an important component of public health education efforts.

## Introduction

Built environments can affect human health in a variety of ways. In residential settings neurotoxins can accumulate in the form of lead particles and pesticide residues.

Despite the existence of chemical-free methods to eradicate pests, Americans use over one billion pounds of pesticides per year [1]. Residues of these pesticides enter homes through tracking with shoes, bare feet, clothing, or animal fur; airborne entry; and soil gas entry [2,3]. Because of spray drift and volatility, adjacency and proximity to agricultural operations can be responsible for residential pesticide residues [4]. Pesticide use in and around homes is another factor responsible for these residues. Numerous health problems occur from exposure to pesticides, such as nervous system damage, cancer, birth defects, leukemia, and ocular toxicity [5]. Because of crawling and hand-to-mouth behaviors, children are more vulnerable than adults to adverse health effects from pesticide exposure. This paper examines exposure risks from pesticide residues in homes and refers to results from a study of those residues in rural homes.

Humans have used lead for various purposes for thousands of years. Despite awareness of the dangers associated with lead, this element continues to appear in a wide range of household products and poses hazards through different exposure pathways. Sources of household lead exposure discussed in this paper include paint dust, drinking water, solder, candle wicks, wood finishes and brass fittings, ceramics, shot and bullets, food and spices, toys and jewelry, vinyl and polyvinylchloride-based plastics and wiring, cosmetics, electronic equipment and electronic waste, contaminated soil, and lead batteries [6]. Lead exposure occurs through ingestion, inhalation, and dermatological contact, and lead poisoning can affect nearly every organ in the body. According to the World Health Organization [7], lead's adverse health effects include cognitive deficits, attention deficit disorder, behavior problems, dyslexia, hypertension, immunotoxicity, reproductive system damage, convulsions, coma, and death. While children are at higher risk of problems associated with lead poisoning, adults are affected as well. Although the United States (U.S.) Centers for Disease Control and Prevention (CDC) has set 3.5 micrograms of lead per deciliter (μg/dL) of blood as a reference level for public health actions, research has demonstrated that there is no threshold for health problems associated with lead exposure [8]. In other words, there is no safe level of contact with lead.

Despite awareness of the dangers of lead exposure, lead in consumer products continues to be the reason for recalls, and the majority of those recalled products originate in China. Consumer education on this topic is ongoing, but should be expanded.

## Materials and Methods

As part of an effort to examine the extent of environmental toxicants in rural homes, tests for lead and pesticide residues were performed in 132 rural homes in New York State. The homes were selected through a two-stage random sampling procedure. First, a hierarchical cluster analysis based on housing characteristics was conducted on New York's 24 non-metropolitan counties. Six clusters were identified through the procedure, and one county was randomly selected from each cluster. Budget constraints limited the sample size to approximately 350 homes. Weighted random sampling based on population was conducted in each county. The final sample size was n=328. Each household was given the opportunity to have pollutant tests conducted, and 132 agreed to this.

The lead and pesticide residue tests will be described and presented in this paper. Full results can be seen in [9] and [10]. A technician visited each of the 132 houses. Surface-dust sampling, with a sterile gauze pad moistened with distilled water, was used to test for lead on the floor beneath windows. This area has been singled out because, before lead paint for residential use was banned in the U.S. in 1978, it was the paint of choice for windows because of its superior adhesive properties. But when window sashes rub against each other, a fine dust is produced that settles to the floor. Because of crawling and hand-to-mouth behaviors, toddlers face a higher risk of lead exposure from this source than adults do.

The U.S. Department of Housing and Urban Development (HUD) has set a hazard level of lead in floor dust at ten micrograms per square foot (μg/sf$^2$). This is also referred to as the clearance level, which means that test results in homes should not exceed that level. Test results are presented in Table 1. Note that test results for two of the houses are missing because of access issues. Note the alarmingly high level of the maximum observed: 660 μg/sf$^2$. The adult head of this household was provided with information and technical assistance to lower this amount to a safe level. Also note that the mean level, 16.92 μg/sf$^2$, is above the HUD clearance level.

Additional wipe samples from a smooth floor area were collected from each participant home. Smooth floor areas include hardwood flooring, sheet vinyl, ceramic tile, etc. Pesticides were selected based on those commonly used in the agricultural practices in the counties that were selected. Samples were analyzed through gas chromatography and mass spectrometry Table 2. The fact that pesticide residues of all pesticides that were tested for were found in every house in our sample indicates the ubiquitous nature of these chemicals in the rural environment. Similar findings were also reported by Obendorf, et al. [11], Smith, et.al. [12], and Starr, et al. [13].

**Table 1:** Lead levels on floors beneath windows.

| Maximum Level (HUD) | Minimum Observed | Maximum Observed | Mean | Standard Deviation | N |
|---|---|---|---|---|---|
| 10 μg/sf$^2$ | 0.04 μg/sf$^2$ | 660 μg/sf$^2$ | 16.92 μg/sf$^2$ | 71.11 | 130 |

**Table 2:** Pesticide levels on smooth floors.

N = 132 for each pesticide

| Pesticide | Mean (μg/m$^2$) | Minimum (μg/m$^2$) | Maximum (μg/m$^2$) |
|---|---|---|---|
| Chlorpyrifos | 0.00641565 | 0.000027 | 0.035563 |
| Methamidophos | 0.01534285 | 0.000022 | 0.091044 |
| Malathion | 0.02316181 | 0.000019 | 0.595709 |
| Picloram Acid | 0.02505954 | 0.000522 | 0.983467 |
| Methyl Parathion | 0.00119004 | 0.000026 | 0.044459 |
| Atrazine | 0.00081807 | 0.000029 | 0.040208 |
| Diazinon | 0.00715122 | 0.000020 | 0.077364 |
| Carbaryl | 0.00305338 | 0.000030 | 0.185368 |
| Prowl | 0.01606887 | 0.000026 | 0.147364 |
| Resmethrin | 0.00056852 | 0.000025 | 0.019740 |
| Tetramethrin | 0.01515323 | 0.000029 | 0.086751 |
| Alachlor | 0.00798413 | 0.000003 | 0.049125 |
| Trifluralin | 0.00209427 | 0.000017 | 0.043156 |
| Metolachlor | 0.01935394 | 0.000028 | 0.136299 |
| 2,4D-acid | 0.00853624 | 0.000350 | 0.226174 |

## Discussion/Results

This study showed that neurotoxins are present in homes. Hazards from lead exposure are well known, yet dangerous lead paint residues are still found in homes. The study also showed residues of five organophosphate pesticides in homes: Chorpyrifos, Methamidophos, Malathion, Methyl Parathion, and Diazinon. This class of pesticides is known to disrupt renal functioning in humans [14]. Picloram Acid is classified by the U.S. Environmental Protection Agency (EPA) as a Restricted Use Pesticide that has been shown to be of moderate to low acute toxicity [15]. Atrazine has been shown to cause reproductive problems [16]. Human exposure to large amounts of carbaryl can be toxic to nervous and respiratory systems [17]. Prowl is classified by the EPA as a possible human carcinogen [18]. Pyrethroids are associated with nervous system damage [19]. Alachlor has the potential to cause cancer in laboratory animals [20]. Trifluralin can cause allergic dermatitis from prolonged exposure [21]. Metolachlor is slightly toxic if ingested [22]. 2,4 D may cause birth defects at high doses [23].

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Numerous studies have documented the incidences of indoor air pollution and its negative impacts on children, especially with respect to lead and pesticides [24]. In addition, studies of indoor air quality have focused on the child breathing zone, which is defined as being from the floor to one meter high [25]. As people and pets walk indoors, pollutants that have settled on the floor are disturbed and re-suspended in the air of that zone. This makes the child breathing zone more polluted than the adult breathing zone. McCaule, et al. [26] reported that residential cleaning practices can significantly reduce pesticide residues, but those practices are specific to different surfaces. This indicates that educators involved in pesticide education programs may want to include program elements that include home maintenance guidelines for prevention of and safe eradication of accumulated pesticide residues of which consumers may not be aware. This could be an important component of public health education efforts.

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