EXECUTIVE SUMMARY

Lead-contaminated house dust was first recognized as an important source of lead for urban children over 20 years ago. In 1992, the United States Congress passed the Residential Lead-Based Paint Hazard Reduction Act, which requires the Environmental Protection Agency (EPA) to promulgate a health-based dust lead standard for residential dwellings based on exposures that are considered dangerous for children.

Objectives

The objectives of this study were: to determine whether dust lead loading (μg/ft5) or dust lead concentration (μg/g) is a better predictor of children's blood lead levels; to investigate whether dust sampling using vacuum methods or a wipe method is more predictive of children's blood lead levels; to identify which interior household surface(s) should routinely be sampled for dust lead measurements; and to estimate the probability of a child having an elevated blood lead level on the basis of a known level of lead in house dust, controlling for other potential exposures.

Methods and Results

Identification and recruitment of eligible subjects was done by using lists of sequential births between March 1, 1991 and September 30, 1992 from three urban hospitals in Rochester, New York. Eligible children were in the 1 to 22 year age range.

Stringent eligibility requirements were imposed to assure that the child's residential environment was the principal likely source of lead exposure. A cross-sectional study design was employed to investigate the relation of lead-contaminated house dust, other potential environmental sources of lead, and urban children's blood lead levels. Field work was done from August through November 1993.

Three dust collection methods were used to obtain side-by-side samples from as many as 12 sampling locations in each house (i.e., a maximum of 36 samples). Two vacuum methods were used to determine both dust lead concentration and dust lead loading: an in-line filter method (the Dust Vacuum Method), and a cyclone-type sampler with a much higher flowrate (the Baltimore Repair and Maintenance study vacuum method). Wipe sampling, which only measures dust lead loading, was also conducted. Thus, there were five dust collection method variables (Dust Vacuum Method dust lead concentration, Dust Vacuum Method dust lead loading, Baltimore Repair and Maintenance vacuum method dust lead loading, Baltimore Repair and Maintenance vacuum method dust lead concentration, and wipe dust lead loading).

In bivariate analyses, all five dust collection method variables on window sills, window wells and carpeted floors, were significantly correlated with children's blood lead levels. Wipe dust lead loading and BRM loading on non-carpeted floors was significantly correlated with children's blood lead levels.

To determine which of the dust collection method measures was most predictive of children's blood lead levels, all five dust collection method variables were entered into the initial multiple regression model, along with all possible covariates which were significant in bivariate analyses. A backward selection process was used to eliminate non-significant covariates while all five dust collection method variables were simultaneously forced to remain in the model. In addition to the dust collection method,

the following covariates were found to be significantly associated with higher blood lead levels among children: Black race, parental reports that children put soil in their mouths, single parent household, and a higher ferritin level.

Each of the five dust collection method variables were then entered individually into separate regression models along with the significant covariates. Dust lead loading using the Baltimore Repair and Maintenance vacuum sampler accounted for the largest amount of variation in children's blood lead levels compared with all other dust collection method variables. The partial correlations for the Baltimore Repair and Maintenance vacuum method dust lead loading and wipe dust lead loading with blood lead was not significantly different. On the other hand, the partial correlation for Baltimore Repair and Maintenance vacuum method dust lead loading and blood lead was significantly different than that for both Baltimore Repair and Maintenance vacuum method dust lead concentration and Dust Vacuum Method dust lead loading.

To determine which types of surfaces (i.e., interior window sills, window troughs (wells), non-carpeted floors, carpeted floors), were the best predictors of blood lead for each dust sampling method, the common covariates were forced into a model and the four surface variables were then allowed to enter through a forward selection process. For Baltimore Repair and Maintenance vacuum method dust lead loading, non-carpeted floors and window troughs were significantly associated with children's blood lead levels, whereas for wipe dust lead loading, non-carpeted floors and interior window sills were significantly associated with children's blood lead levels.

Using logistic regression to adjust for other significant covariates, the proportion of children estimated to have a blood lead level exceeding 10 μg/dL (micrograms of lead per deciliter of blood) was 4.3%, 15%, and 20% at 5 μg/ft5 , 20 μg/ft5 and 40 μg of lead/ft5 respectively, for non-carpeted floors using wipe sampling. Similar analyses are presented for carpeted floors, window sills and window troughs.

Conclusions

Dust lead loading is a better predictor of children's blood lead levels than is dust lead concentration for the range of lead-contaminated dust and blood lead levels observed in this study. Any household dust lead standard should be linked to the method by which dust is sampled, because the relationship between children's blood lead levels and dust lead levels varies significantly by method of dust collection. The relationship between blood lead levels and household dust lead is different for floors, window sills, and window troughs using the same dust collection method, indicating that different standards are needed for each surface. To determine if a housing unit is safe for children, non-carpeted floors and interior window sills or window troughs can be measured using either the Baltimore Repair and Maintenance vacuum method or wipe sampling method.

Settled, lead-contaminated house dust (at levels observed in this study) is an important contributor of lead to children who have low level elevation of blood lead levels (i.e., blood lead levels up to 20 μg/dL). This study suggests that the proportion of urban children having a blood lead level exceeding 10 μg/dL increases at levels lower than current HUD post-abatement clearance standards and the recently released EPA guidance levels. Future research should seek to confirm the estimated relationship between children's blood lead levels and lead contaminated housedust found in this study. Also, further research should investigate whether dust control is associated with a meaningful decrease in blood lead levels of children at today's lead exposures.