Abstract 746: Pediatric Bioavailability of Lead in Soil and Dust: Estimates from Soil, House Dust, and Blood Lead at the Bunker Hill Superfund Site

Background

In risk assessment, bioavailability refers to the fraction of an external dose that enters systemic circulation (National Academy of Sciences, 2003). If the concentration of lead in environmental media available for exposure is the external dose, then bioavailability can include ingestion rates as well as the uptake fraction. Lead exposure from soil or dust is modeled as the product of concentration (µg/g), ingestion rate (g/day), and the fraction of lead available for uptake (i.e., bioavailability). See Figure 1 for predicted and observed blood lead levels using an aggregate soil/dust bioavailability of 18%.

Methods

Blood lead levels were converted to lead uptake using age-specific biokinetic slope factors which are the basis of the IEUBK Lead Model (Harley & Kneip, 1985; U.S. Environmental Protection Agency, 2001).

Separating soil and dust bioavailability

Separating soil and dust bioavailability is sensitive to soil and dust ingestion rate assumptions. However, assuming 10% soil and 25% dust bioavailability explains the annual variation in aggregate soil/dust bioavailability observed from 1988 to 2002 using IEUBK soil/dust ingestion rates. Greater bioavailability of dust may be caused by smaller particles in dust relative to soil which may account for an increase in bioavailability (by greater surface area) and ingestion rate (smaller particles are more likely to cling to hands and fingers).

Results

Although measurements of lead bioavailability in soil media are available, similar measurements for lead in dust are lacking (National Academy of Sciences, 2003). Relative bioavailability of lead in soil and dust can be inferred from slope factors which relate concentrations in environmental media to blood lead concentrations in children, but this necessarily combines absorption with ingestion and other measures of exposure. Although soil and dust slope factors are highly variable, values soil slope factors are generally less than dust slope factors (Saucer et al., 1998). Direct comparison between soil and dust bioavailability is impeded by differences in units. Soil lead is reported as a mass based concentration while dust lead is often reported as a mass per area basis (i.e., loading) which is a weighted average of particle size (Kissel et al., 1996). Differences in bioavailability could be caused in part by enhanced dermal adherence, ingestion, and absorption due to smaller particle size (Kissel et al., 1996; Steele et al., 1990; U.S. EPA Technical Review Workgroup for Lead, 1999). Differential assumptions of soil and dust bioavailability could be used to refine risk assessments and predictive blood lead modeling.

Discussion

Analysis of estimated annual aggregate bioavailability and the relative soil and dust intakes suggest geometric mean bioavailability of 10% and 23%, respectively (average dust: 20%; soil: 10%). These results are consistent with observed increases in aggregate bioavailability during years when dust lead intakes were greater than soil lead intakes and predicted blood lead levels were below observed levels. Greater effective bioavailability of dust relative to soil could be caused in part by enhanced dermal adherence, ingestion, and absorption due to smaller particle size (Kissel et al., 1996; Steele et al., 1990; U.S. EPA Technical Review Workgroup for Lead, 1999). Differential assumptions of soil and dust bioavailability could be used to refine risk assessments and predictive blood lead modeling.

References


