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An Evaluation of Soil Lead Guidance Values Derived from the Integrated Exposure Uptake Biokinetic (IEUBK) Model

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Background and Purpose: In January 2024, the United States Environmental Protection Agency (US EPA) lowered the residential soil lead (Pb) regional screening level (RSL) and removal management level (RML) from 400 parts per million (ppm) to 200 ppm. In cases where an additional source of Pb is identified, US EPA recommends that an RSL of 100 ppm be used. US EPA used the Integrated Exposure Uptake Biokinetic (IEUBK) model with a target blood lead level (BLL) of 5 micrograms per deciliter (µg/dL) to derive the RSL of 200 ppm and a target BLL of 3.5 µg/dL to derive the RSL of 100 ppm. Several recent studies suggest that certain IEUBK model defaults (e.g., mass fraction of soil in indoor dust [MSD], age-specific soil/dust ingestion rates, and age-specific dietary Pb intake rates) should be updated to reflect the best available science. Further, the IEUBK model has not been validated for target BLLs ≤ 5 µg/dL, which form the basis of the updated soil Pb guidance values.

Methods: To evaluate the accuracy of the IEUBK model when a target BLL of ≤ 5 µg/dL is used, we compared predicted BLLs to observed BLLs (*i.e.*, geometric mean, 50th, 75th, 90th, 95th, and 97.5th percentiles) that were reported in the most recent National Health and Nutrition Examination Survey (NHANES) cycle. Additionally, we identified and evaluated studies of the M_{SD}, age-specific soil/dust ingestion rates, and age-specific dietary Pb intake rates, with particular focus on studies published since the last update to IEUBK model default inputs. Using updated IEUBK model inputs, we modeled alternative soil Pb guidance values for a target BLL of 5 µg/dL and 3.5 µg/dL.

Results: For both soil Pb guidance levels, the IEUBK overpredicted the risk of exceeding a particular BLL cutoff. For example, the probability of observing a BLL > 3.5 µg/dL in the US population of children aged 1-5 years is 2.5%. However, the model-predicted probability of observing a BLL > 3.5 µg/dL is 18.7% and 6.3% for soil Pb of 200 ppm and 100 ppm, respectively. Recent studies support an alternative M_{SD} of ≤ 0.4, which is lower than the IEUBK model default of 0.7. Further, there is evidence that estimated soil/dust ingestion rates and dietary Pb intake rates in US children are lower than the IEUBK model default values. We conducted a modeling exercise using updated IEUBK model inputs and found that the soil Pb guidance values would be higher than the current RSLs. For example, soil Pb guidance values derived using updated IEUBK model inputs ranged from 250 to 740 ppm (for a target BLL of 5 µg/dL) and 110 to 430 ppm (for a target BLL of 3.5 µg/dL).

Conclusions: The IEUBK model overpredicts the risk of exceeding a BLL cutoff of 5 µg/dL and 3.5 µg/dL when an RSL of 200 ppm and 100 ppm is used. Further, several recent scientific studies support that the estimated M_{SD}, age-specific soil/dust ingestion rates, and age-specific dietary Pb intake rates are lower than the IEUBK model default values. Our modeling results show that incorporating updated IEUBK model values would result in higher soil Pb guidance values for target BLLs of 5 µg/dL and 3.5 µg/dL.