SHORT SHEET:

What Is The Interindividual Geometric Standard Deviation (GSDi) Used In The Integrated Exposure Uptake Biokinetic (IEUBK) Model?

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Technical Review Workgroup Lead (Pb) Committee

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The geometric standard deviation (GSD) is a statistical measure of the spread of data in relation to its geometric mean. U.S. EPA's residential lead risk model, the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK model) uses interindividual geometric standard deviation (GSDi) to represent observed variability[1] among similarly exposed children in their interindividual blood lead concentrations (PbB). This approach for representing interindividual variability in PbB is used by other EPA program offices, including the Office of Air and Radiation, and federal agencies, including the Department of Defense (NAS, 2020).

IEUBK Model

The default GSDi value (1.6) in the IEUBK model is intended to be applicable to most sites in the United States. The GSDi for children is intended to include biological and behavioral variability, measurement variability from repeat sampling, sample location variability, and analytical error, but not variability in blood lead concentrations where different children are exposed to substantially different media concentrations of lead.

The default GSDi value of 1.6 used in the IEUBK model was based on robust empirical datasets from several sites (White et al., 1998). Several approaches to estimating a GSDi were applied, two of which are discussed in this document.[2]

Child PbB data from the Midvale, Utah site, the Butte, Montana site, and the Baltimore data of the Urban Soil Lead Abatement Demonstration Project were stratified into age and soil Pb level cells (ranges). GSD values were calculated for each cell and the degrees of freedom-weighted median GSD across cells was used to represent the GSDi. This approach yielded the following GSDi estimates: 1.5 (Baltimore, n not available), 1.6 (Butte, n= 273) and 1.8 (Midvale, n=255).

An alternative approach derived a nonlinear regression model relating PbB to age and soil Pb level using the Midvale data, and the GSDi was estimated from the residual variance of the model fit. The resulting estimate of the GSDi was 1.8 (95% confidence interval: 1.6-1.9).

These results support a value of 1.6 for the GSDi; the mid-range value from the cell-median approach (Midvale) and the lower 95% confidence limit from the regression approach (Midvale). The default GSDi value in the IEUBK model of 1.6 has also been supported by independent analyses, including the National Academy of Sciences (NAS) Review of Superfund and Mining Megasites – Lessons from the Coeur d'Alene River Basin (NAS, 2005) and U.S. EPA's evaluation of the IEUBK model performance using data

[1] Reflects observed variability based on different behaviors that affect intake, measurement variability, biological diversity, sociodemographic factors and uptake and absorption for individuals.

[2] Information regarding the complexities of developing a site-specific GSDi value is discussed in U.S. EPA, 1994 [see Section 4.2.2 and Appendix A].

from the Bunker Hill Mining and Metallurgical Complex (Brown et al. 2022; U.S. EPA, 2021).

In general, the Technical Review Workgroup (TRW) Lead Committee does not recommend that site-specific estimates of the GSDi be attempted. As discussed in Section 4.5 *Guidance Manual for the Integrated Exposure Update Biokinetic Model* (U.S.EPA, 1994), blood lead studies may be subject to subtle sampling biases and changes in child behavior in respond to the study. The GSD[i] value reflects child behavior and biokinetic variability. “Unless there are great differences in child behavior and lead biokinetics among different sites, the GSD[i] values should be similar at all sites, and site-specific GSD[i] values should not be needed.”

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