Overview of Changes to IEUBK Model Software from IEUBKwin version 1.1 build 11 to IEUBKwin version 2.0 build 1.63

The following changes made have been made in this version of the Integrated Exposure Uptake Biokinetic (IEUBK) model software:

- Updated model input variables for dietary lead exposure using data from the National Health and Nutrition Examination Survey (NHANES) and statistical methodology developed by the National Cancer Institute (NCI).
- Updated model input variables for drinking water consumption using data from the 1994-1996 and 1998 CSFII database and drinking water concentration using data from the 1998-2005 National Compliance Monitoring Information Collection Request.
- Updated baseline maternal blood lead concentration (PbB) using data from NHANES.
- Replaced the inhalation rates with rates that were estimated using a database of doubly-labeled water energy expenditure developed by the institute of Medicine (IOM).
- Updated the soil/dust ingestion rates based on an analysis of soil, indoor dust and blood lead concentration data from the Bunker Hill Superfund Site.
- Changed calculations that are not apparent to user: fixed calculation of GM to sum & divide by number of iterations; calculating just 6 months for 6 to 12 months in the yearly averages.
- Changed the 'Find' function and 'Run' to reflect P5 target and recommended age range (12-72 months) by default.
- Changed the graphical user interface (GUI) to simplify use, improve appearance and update all links to the TRW homepage.
- Changed the output files to report ages consistently in months.
- Windows 10 environments officially supported.
- Updated the help file to correspond to the updated versions of the IEUBK documentation.

Dietary Lead Update

Version 2.0 reflects new data on food lead concentrations from the Food and Drug Administration's (FDA) market basket survey (FDA, 2010), food consumption data from NHANES (CDC, 2010a,b) and an improved method for estimating food consumption rates developed by the NCI (Tooze et al., 2006). See Table 1.

Table 1. Default and updated values for dietary lead intake in the IEUBK model.

Age Category (months)	IEUBK v1.0 Default Dietary Lead Intake (µg/day)	Previous Recommended Update Dietary Lead Intake (1991-1999 TDS data) (µg/day)	IEUBK v1.1 Updated Dietary Lead Intake Estimate (1995-2003 TDS data) (µg/day) [0.1LOD–0.9LOD]	IEUBK v2.0 Updated Dietary Lead Intake Estimate (1995-2005 TDS data) 2003-2006 NHANES WWEIA (µg/day)
0-11	5.53	3.16	2.26 [1.51–3.01]	2.66
12-23	5.78	2.60	1.96 [1.18–2.74]	5.03
24-35	6.49	2.87	2.13 [1.24–3.03]	5.21
36-47	6.24	2.74	2.04 [1.18–2.90]	5.38
48-59	6.01	2.61	1.95 [1.13–2.77]	5.64
60-71	6.34	2.74	2.05 [1.17–2.92]	6.04
72-84	7.00	2.99	2.22 [1.26–3.18]	5.95

Drinking Water Consumption

The default values for water consumption rates in Version 2.0 are based on an analysis of data from the 1994-1996 and 1998 CSFII database (Kahn and Stralka, 2009). The updated consumption rates are for *consumers only* and correspond to estimates that include all water sources. See Table 2.

Table 2. Default and updated values for water consumption rates in the IEUBK model.

Age Category (months)	IEUBK v1.0 Default Water Consumption Rate (L/day)	IEUBK v2.0 Updated Water Consumption Rate (Kahn and Stralka, 2009) (L/day)
0-11	0.20	0.40
12-23	0.50	0.43
24-35	0.52	0.51
36-47	0.53	0.54
48-59	0.55	0.57
60-71	0.58	0.60
72-84	0.59	0.63

Drinking Water Lead Concentration

The default value of the water lead concentration variable in Version 2.0 has been changed from 4 to 0.9 µg/L. This variable is used to represent the lead concentration in drinking water at the site. The updated value is based on an analysis of water lead concentration data that was developed for the U.S. EPA's Second Six-Year Review of National Primary Drinking Water Regulations (EPA, 2010a, b)[1].

Inhalation Rate

Version 2.0 includes updated inhalation rates that were estimated using data published by the IOM (IOM, 2005). The IOM data were selected following a literature review to identify data and methods for estimating inhalation rates for children. The updated inhalation rates are based on a non-linear regression model estimated using a doubly-labeled water energy expenditure database developed by the IOM. See Table 3.

Table 3. Default and updated values for inhalation rates in the IEUBK model.

Age Category (months)	IEUBK v1.0 Default Inhalation Rate (m^3/day)	IEUBK v2.0 Updated Inhalation Rate Estimate (IOM, 2005) (m^3/day)
0-11	2	3.22
12-23	3	4.97
24-35	5	6.09
36-47	5	6.95
48-59	5	7.68
60-71	7	8.32
72-84	7	8.89

[1]The water lead concentration in drinking water database developed by EPA (2010A,B) using data obtained from the 1998-2005 National Compliance Monitoring Information Collection Request Dataset (i.e., "Six-Year Review-ICR Dataset") was not published as part of the Six-Year Review of National Primary Drinking Water Regulations (U.S. EPA, 2010a,b). The database was delivered by U.S. EPA Office of Groundwater and Drinking Water to the TRW for the purpose of estimating an updated drinking water lead concentration value for the EIBUK Model.

Soil/Dust Ingestion Rate

Version 2.0 includes updated soil/dust ingestion rates that are based on an analysis of data from the Bunker Hill Superfund Site (von Lindern et al., 2016). The updated values were derived using structural equation modeling with lead concentration data for soil and indoor dust, site-specific soil and indoor dust bioavailability data and blood lead concentration data. See Table 4.

Table 4. Default and updated values for soil/dust ingestion rates in the IEUBK model.

Age Category (months)	IEUBK v1.0 Default Soil/Dust Ingestion Rates (mg/day)	IEUBK v2.0 Updated Soil/Dust Ingestion Rates (von Lindern et al., 2016) (mg/day)
0-11	85	86
12-23	135	94
24-35	135	67
36-47	135	63
48-59	100	67
60-71	90	52
72-84	85	55

Changes to the GUI

IEUBKwin Version 2.0 implements several changes to the GUI to make the model easier to use and understand. User-defined age ranges (in months) are now available for all for all run modes and output is presented for only the months selected. All output is expressed in terms of months. Batch mode output now includes the absorption fraction that was used in the batch run. The default cutoff blood lead concentration on the Find and Run functions has been lowered from 10 µg/dL to 5 µg/dL.

Software Installation and Environment

The IUEBK model software has been ported to the latest Microsoft build tools, migrated to work in the Windows 10 environment and enhanced to be backward compatible with the Windows 7 environment. Users can select compatibility mode to run the IEUBK model in earlier versions of Windows. Version information is now read from and held in Version.txt file for version verification outside the software and to support continuous integration build process.

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