# Predicting Blood Lead Levels by Modeling Soil Lead Exposure Frequency and Duration – A Work in Progress –

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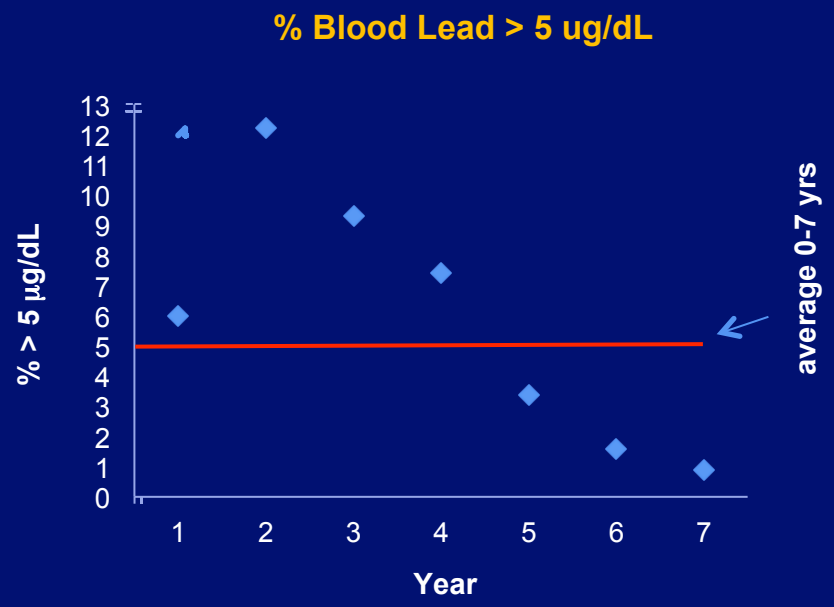
# Background

- **CDC blood lead reference value lowered to 5 µg/dL (2012)**
- **EPA's Integrated Exposure Uptake Biokinetic (IEUBK) model is currently used for predicting blood lead levels (BLLs)**
- **ATSDR is investigating using other physiologically based pharmacokinetic (PBPK) models for short-term lead exposures**
  - Currently testing the All Ages Lead Model (AALM)

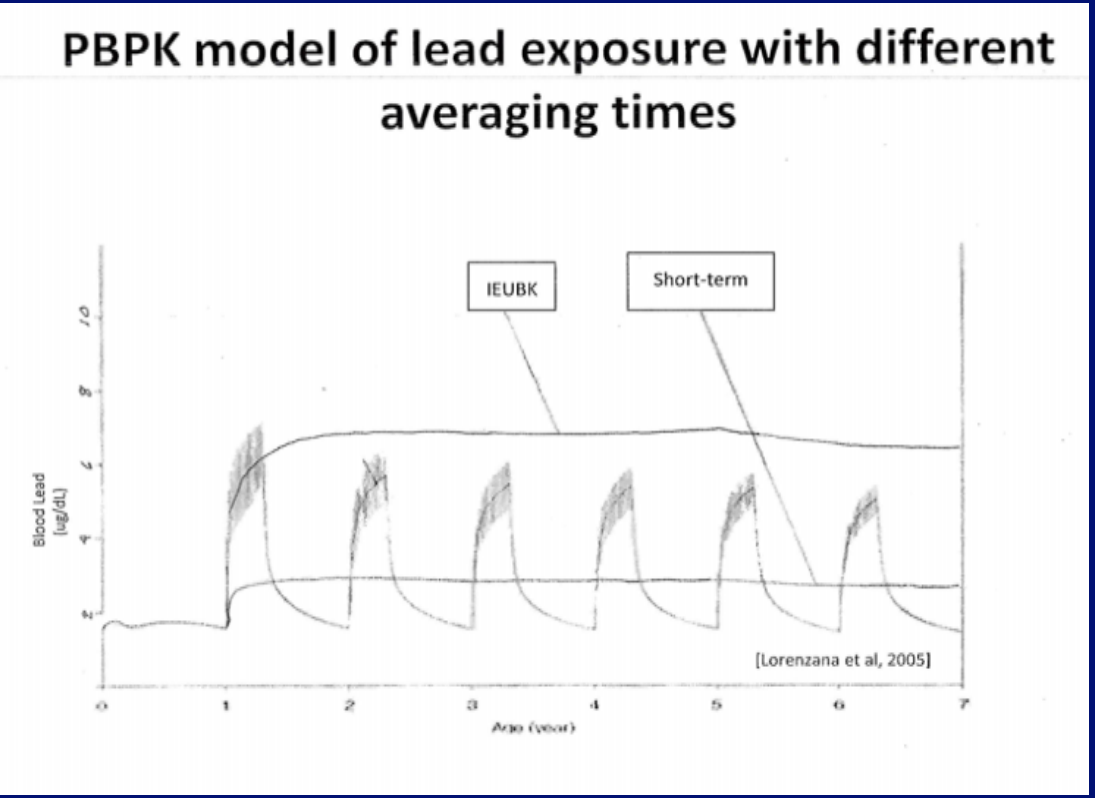
# Need for more investigation

- **Need to model shorter-term and less frequent exposures**
- **IEUBK model**
  - One year minimum exposure duration
  - Default exposure duration has been averaged 0-7 years



# Need for more investigation

- Recent PBPK models allow for more descriptive exposure scenarios and averaging times.



# Public Health Implications

**Using the AALM provides:**

- **An estimate of BLLs based on site-specific exposure conditions, including seasonality, frequency, duration, and concentration.**
- **A means of describing the degree of concern based on the relationship to 5 μg/dL using probabilities.**
- **An opportunity for ATSDR to design site-specific interventions, based on site-specific scenarios, to reduce lead exposures.**

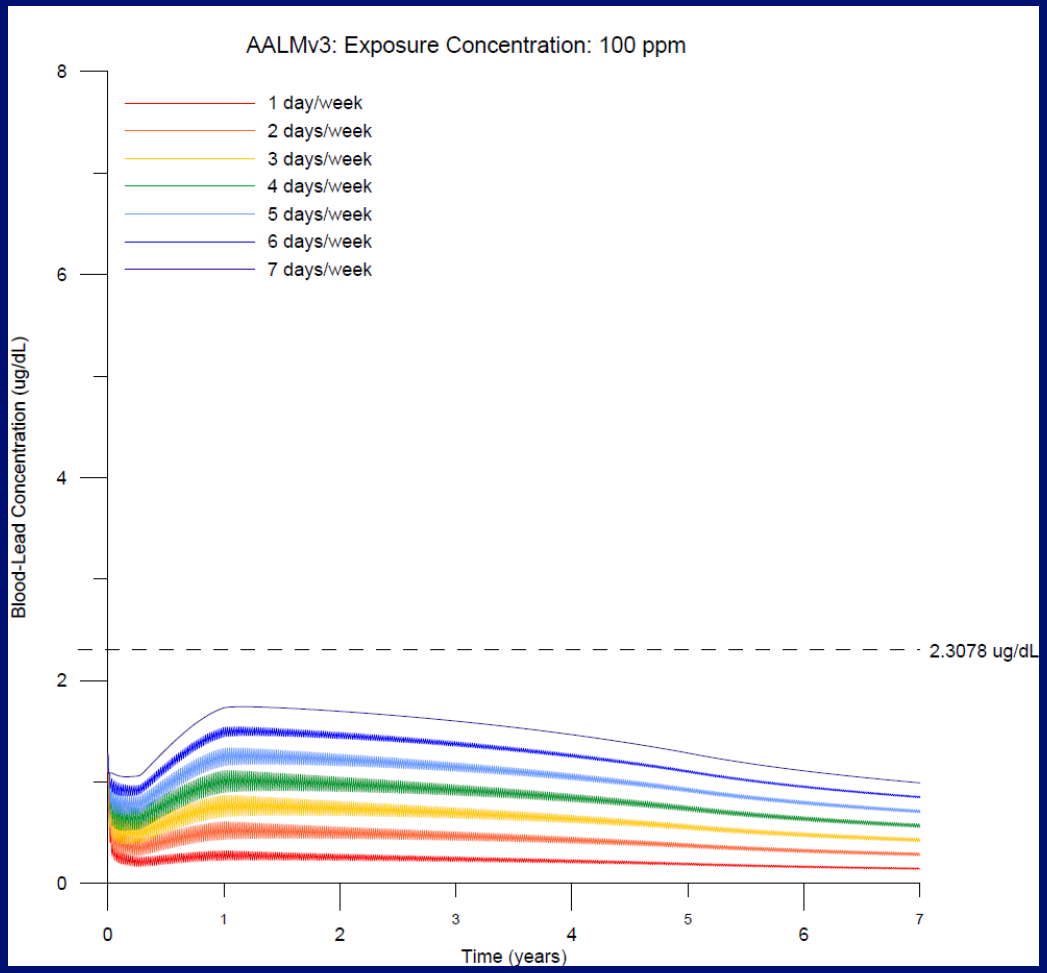
# ATSDR activities (completed)

- **Investigated PBPK models for short-term, intermittent, and seasonal exposures.**
- **During *beta* testing of the EPA All Ages Lead Model (AALM) worked with Syracuse Research to develop model execution files to predict ATSDR exposure scenarios.**
  - Modeled blood lead levels (BLLs) for different frequencies, durations, and soil lead levels.
  - Modeled seasonal and day-care exposure scenarios.
  - Derived probabilities of simulated BLLs (% probability of exceeding 5 μg/dL BLL).

# PBPK Results – AALMv3

## predicted BLL by exposure frequency and duration

- **Soil Concentration: 100 ppm**
- **Exposure from birth to age 7.**
- **Predicted geometric mean BLL does not exceed a 5% probability of exceeding 5 μg/dL for any exposure frequency or duration.**

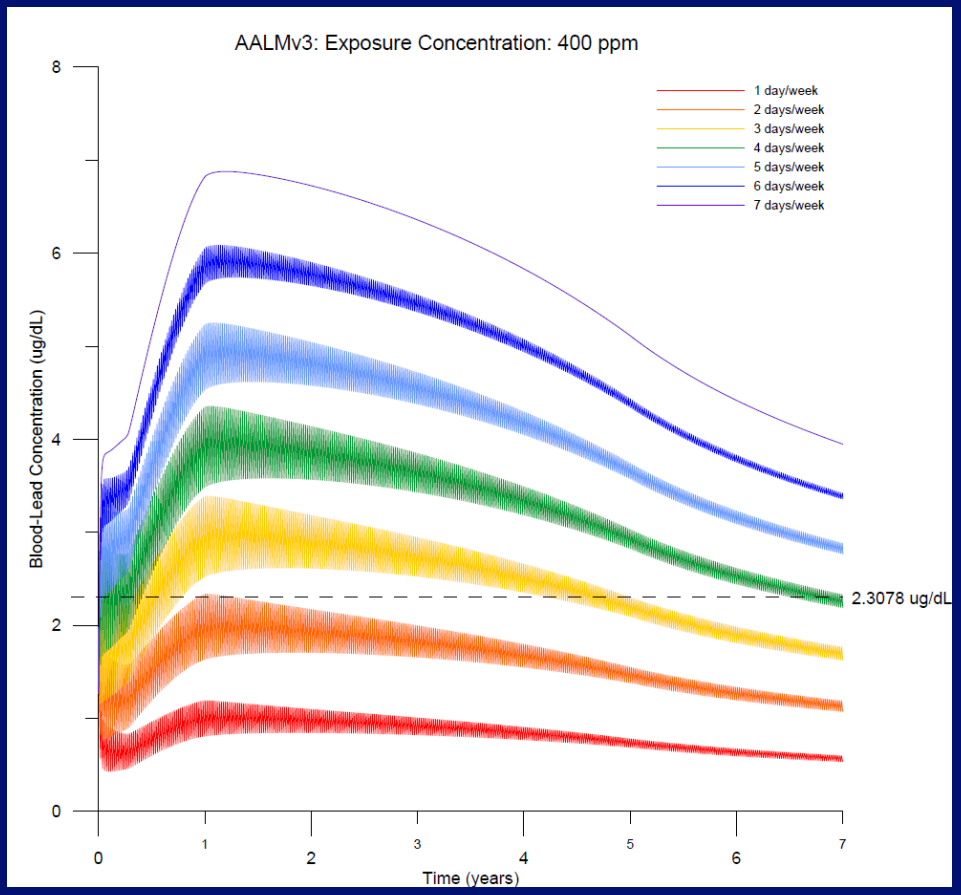



* The 2.3078 μg/dL line is the geometric mean resulting in a probability of 5% of BLLs equaling 5 μg/dL

# PBPK Results – AALMv3

## predicted BLL by exposure frequency and duration

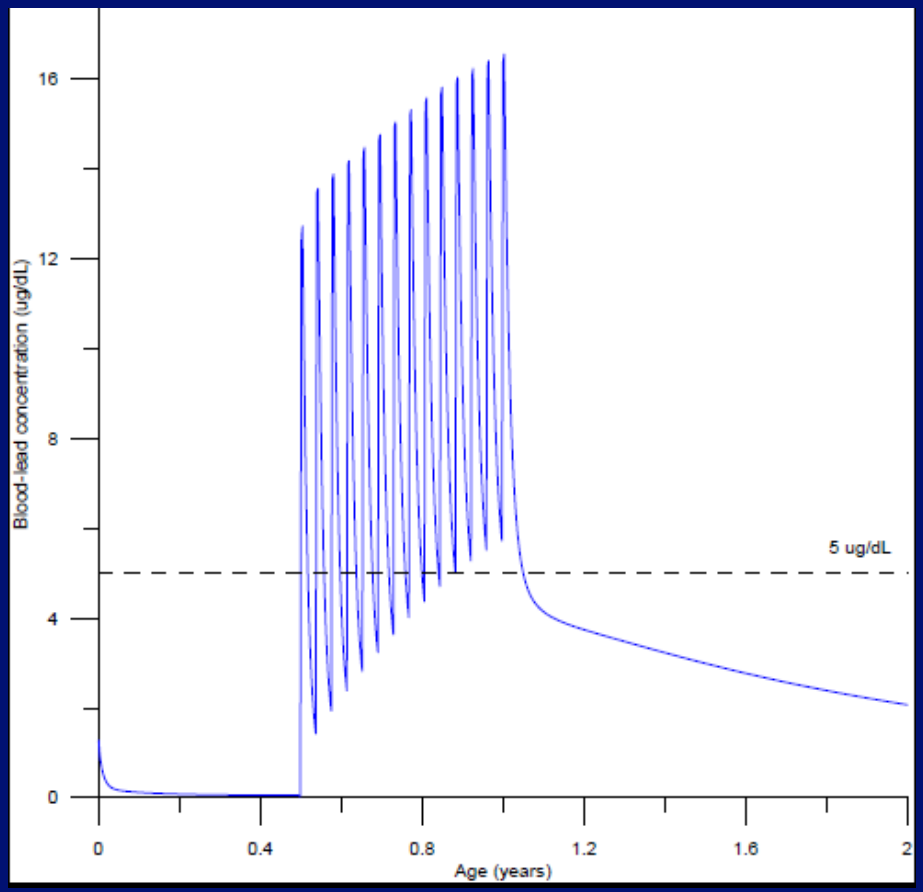
- Soil Concentration: 400 ppm
- Exposure duration: birth to age 7
- Predicted geometric mean BLL does not exceed 5 μg/dL for exposures occurring 2 days/week or less for all ages.
- Exposures occurring 3 days/week may result in a greater than 5% probability of a BLL exceeding 5 μg/dL for ages 6 months to about 5 years.
- Exposures occurring 4 days/week or more may result in a greater than 5% probability of a BLL exceeding 5 μg/dL for ages 7 and under.




* The 2.3078 μg/dL line is the geometric mean resulting in a probability of 5% of BLLs equaling 5 μg/dL

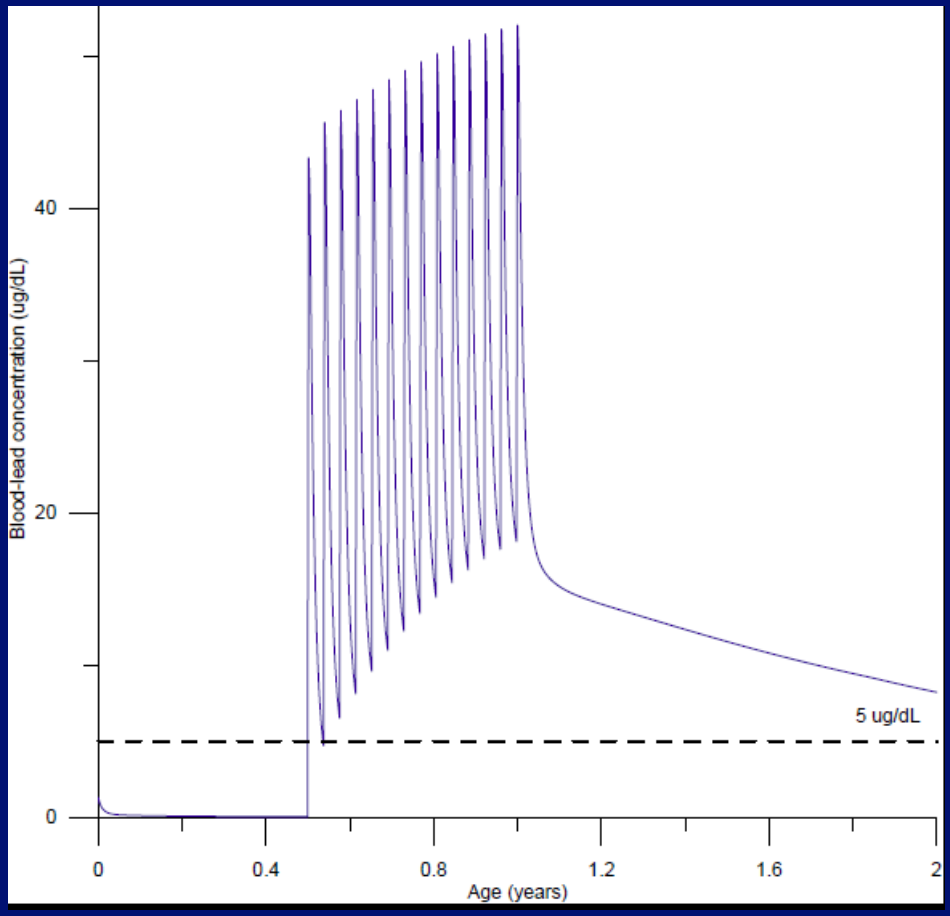
# Simulation of Pica Exposure Scenario – AALMv3

- Soil Concentration: 100 ppm
- Pica Ingestion Rate: 5000 mg soil/day
- Exposure Duration: 6 months – 1 year
- Exposure Frequency: once every two weeks
- Peak BLLs: 12 – 16 µg/dL
- Between pica episodes, BLLs return to below 5 µg/dL for ages 6 – 10 months.
- BLLs fall below 5 µg/dL quickly after end of pica episodes.



# Simulation of Pica Exposure Scenario – AALMv3

- Soil Concentration: 400 ppm
- Pica Ingestion Rate: 5,000 mg soil/day
- Exposure Duration: 6 months – 1 year
- Exposure Frequency: once every two weeks
- Peak BLLs: 43 – 52 ug/dL
- Between pica episodes, BLLs generally stay above 5 ug/dL from the start of the pica episodes until over one year after they end.

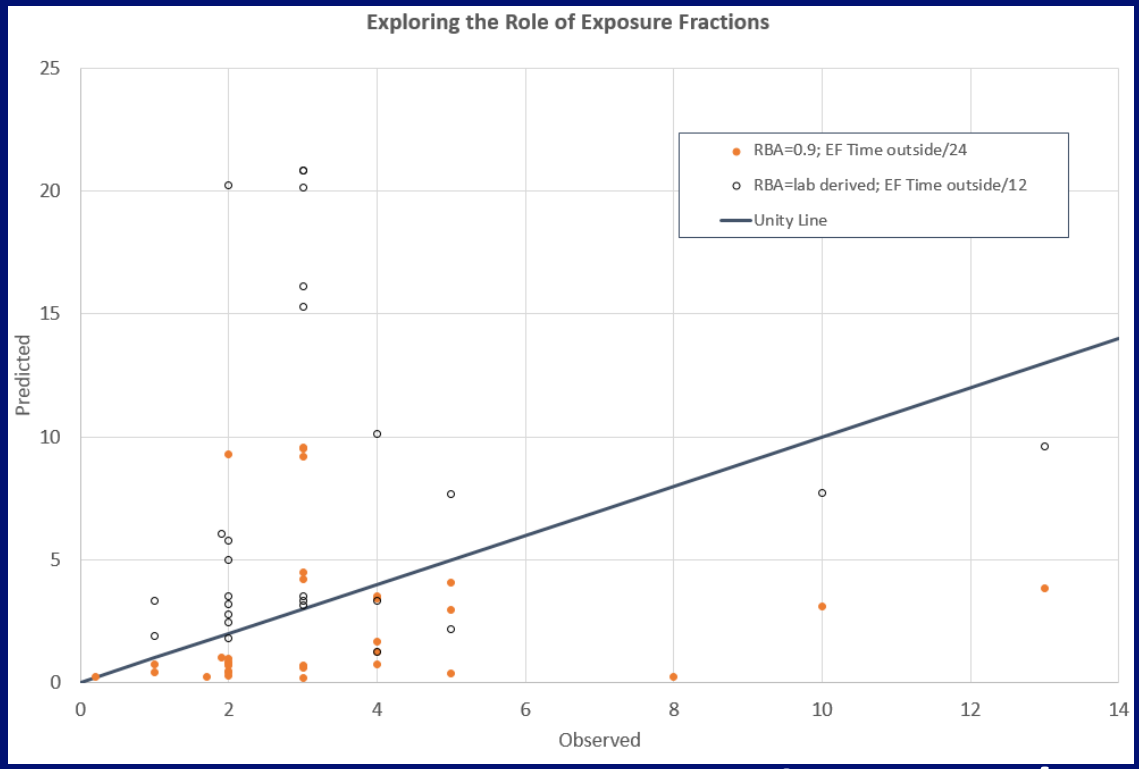


# Current ATSDR Discussions

- **Scientific**
  - Can the AALM PBPK model be used to inform short-term, acute, and *pica* lead exposures?
  - How should exposure fractions be assigned in the AALM?
  - How should ATSDR average lead exposures?
    - Yearly? 3 months? 6 months?
  - How should ATSDR consider peak lead exposures?
- **Logistic**
  - Vetting/approval of ATSDR's approach for lead evaluations

# Current Activities
# AALM V4.2

- Currently testing the model using JT Lewis data.
- Refining exposure fractions




- <u>May</u> require data from other sites (new and/or existing)

# Acknowledgements


- **Modeling team**
  - Rachel Worley
  - Eva McLanahan
- **Lead SMEs**
  - Diane Jackson
  - Dave Mellard
- **JT Lewis site team**