

Supporting Information for Article:
The Contribution of Particle Size Fractioned Airborne Pb to Blood Pb
during NHANES 1999-2008

Qingyu Meng¹, Jennifer Richmond-Bryant*², J.Allen Davis², Jonathan Cohen³, David Svendsgaard², James S. Brown², Lauren Tuttle⁴, Heidi Hubbard³, Joann Rice⁵, Ellen Kirrane², Lisa Vinikoor-Imler², Dennis Kotchmar², Erin Hines², Mary Ross²

¹School of Public Health, University of Medicine and Dentistry of New Jersey, 683 Hoes Lane West, Piscataway, NJ 08854 USA

²National Center for Environmental Assessment, U.S. Environmental Protection Agency, 109 TW Alexander Drive, B243-01, Research Triangle Park, NC 27711 USA

³ICF International, 9300 Lee Highway, Fairfax, VA 22031 USA

⁴School of Architecture, The University of Texas at Austin, 1 University Station B7500, Austin, TX 78712-0222 USA

⁵Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, 109 TW Alexander Drive, C304-04, Research Triangle Park, NC 27711 USA

*Corresponding Author: National Center for Environmental Assessment, Office of Research and Development, US EPA, Research Triangle Park, NC 27711; (919) 541- 4518; (919) 541-2985 (fax); Richmond-Bryant.Jennifer@epamail.epa.gov

Submitted for publication in *Environmental Science & Technology*
September 2013

Revised manuscript submitted
December 2013

Contents

| | |
|--|----|
| Supplement to the methodology | S2 |
| Table S1. The association between blood lead and air lead, indicated by the LME model with covariates (Equation S1) slopes of air lead, stratified by particle size, age group, and air lead averaging time. | S3 |
| Reference | S4 |

Supplement to the methodology

Various covariates were considered in our analysis (Equation S1). These covariates reflect lead (Pb) exposures which might not be captured by the measured ambient air Pb (PbA). Individual level covariates were obtained from the NHANES 1999-2008 database, including demographic information, socioeconomic status, exposure history, body storage and mobilization of Pb, exposure from indoor Pb dust resuspension, exposure to Pb-based paint, exposure to Pb in tap water, and potential occupation exposures¹. These covariates were linked with individual blood Pb (PbB) concentrations using a unique subject ID.

Small differences existed between the covariate variables included in the two-year cycles during NHANES 1999-2008. Where appropriate, these covariate variables were reconciled by recoding to make the value definitions consistent¹. Missing values of the covariate variables were imputed before analysis¹.

The normalized road length, was generated with ArcGIS (version 9.3, ESRI) to reflect subjects' near-road exposures to Pb. The normalized road length was defined as the total length of street per census block group normalized by the census block group area. Road data within GIS were only available for the year 2000. The normalized road length was linked to PbB examination by the 2000 census block ID.

Statistical analysis

A multi-level linear mixed effect model (Equation S1) was developed to obtain estimates of the relationship between PbB and ambient PbA concentrations. The multi-level modeling was performed at the individual and Census block levels.

$$\ln(PbB_{i,j}) = \beta_0 + \beta_i Z_i + b_j + \beta_{PbA} \ln[{}^t PbA_j] + \varepsilon_{i,j} \quad (S1)$$

where $PbB_{i,j}$ is the PbB for the i^{th} individual living in the j^{th} Census block; Z_i is the vector of covariates (e.g., age, race/ethnicity, housing age) for the i^{th} individual, β is the associated coefficient vector; $[{}^t PbA_j]$ is the average ambient PbA concentration obtained at the j^{th} Census block or over an averaging period of length t , and β_{PbA} is the slope of $\ln(PbB)$ on $\ln(PbA)$ over an averaging period of length t (and \ln denotes the natural logarithm). The covariate and ambient PbA concentration variables are fixed effects. β_0 is the overall intercept, b_j is a Census block-level random normal intercept with mean zero and variance τ^2 , and $\varepsilon_{i,j}$ is a random normal variable with mean zero and variance σ^2 .

The PbB-PbA associations estimated by the model above are presented in Table S1.

Table S1. The association between PbB and PbA, indicated by the LME model with covariates (Equation S1) slopes of PbA, stratified by particle size, age group, and PbA averaging time.

| PM Size | Age Group | Current PbA Concentration | | | | | Average PbA Concentration in the Past 90 Days | | | | |
|-------------------|-----------|---------------------------|--------|------------------|------------------|---------|--|--------|-------|------|---------|
| | | N | Slope | CLL ^a | CLU ^b | P-value | N | Slope | CLL | CLU | P-value |
| TSP | 1-5 | 178 | 0.037 | -0.07 | 0.15 | 0.516 | 191 | -0.026 | -0.12 | 0.07 | 0.596 |
| | 6-11 | 212 | 0.032 | -0.06 | 0.12 | 0.488 | 237 | 0.042 | -0.05 | 0.13 | 0.367 |
| | 12-19 | 414 | 0.058 | -0.01 | 0.12 | 0.084 | 470 | 0.060 | 0.00 | 0.12 | 0.069 |
| | 20-59 | 508 | 0.000 | -0.05 | 0.05 | 0.995 | 563 | 0.005 | -0.04 | 0.05 | 0.829 |
| | ≥ 60 | 258 | 0.009 | -0.07 | 0.09 | 0.817 | 276 | -0.023 | -0.10 | 0.05 | 0.536 |
| PM ₁₀ | 1-5 | 2150 | 0.095 | 0.07 | 0.12 | <0.001 | 2204 | 0.111 | 0.08 | 0.14 | <0.001 |
| | 6-11 | 2261 | 0.064 | 0.04 | 0.09 | <0.001 | 2337 | 0.084 | 0.05 | 0.12 | <0.001 |
| | 12-19 | 4787 | 0.065 | 0.05 | 0.08 | <0.001 | 4942 | 0.089 | 0.07 | 0.11 | <0.001 |
| | 20-59 | 7842 | 0.025 | 0.01 | 0.04 | <0.001 | 8066 | 0.029 | 0.01 | 0.05 | 0.001 |
| | ≥ 60 | 3510 | 0.057 | 0.04 | 0.08 | <0.001 | 3594 | 0.067 | 0.04 | 0.09 | <0.001 |
| PM _{2.5} | 1-5 | 193 | 0.041 | -0.05 | 0.13 | 0.354 | 220 | 0.029 | -0.15 | 0.21 | 0.756 |
| | 6-11 | 200 | 0.055 | -0.02 | 0.13 | 0.164 | 241 | 0.197 | 0.05 | 0.34 | 0.007 |
| | 12-19 | 392 | 0.038 | -0.03 | 0.10 | 0.252 | 457 | -0.055 | -0.19 | 0.08 | 0.435 |
| | 20-59 | 614 | -0.028 | -0.08 | 0.02 | 0.286 | 704 | -0.063 | -0.16 | 0.03 | 0.179 |
| | ≥ 60 | 245 | 0.046 | -0.04 | 0.13 | 0.273 | 285 | -0.066 | -0.20 | 0.07 | 0.340 |

^aLower bound of the 95% confidence limit; ^bupper bound of the 95% confidence limit.

Reference

(1) Richmond-Bryant, J.; Meng, Q.Y.; Davis, J.A.; Cohen, J.; Svendsgaard, D.; Brown, J.S.; Tuttle, L.; Hubbard, H.; Rice, J.; Kirrane, E.; Vinikoor-Imler, L.; Kotchmar, D.; Hines, E.; Ross, M. A multi-level model of blood lead as a function of air lead. *Sci.Total Environ.* **2013**, 416-462: 207-213; DOI 10.1016/j.scitotenv.2013.05.008.