

## Appendix D: IQ Effects from Blood Lead Levels

The following articles are the source for IQ effects for BLLs. The abstract provides the background data for the log form multiplier used by the model. The EPA paragraph provides the background data for the linear form multiplier used by the model.

Articles in Environ Health Perspectives, July 2005, Vol. 113(7), pages 894-9. With Comment in Environ Health Perspectives, February 2006, Vol. 114(2), A85-6; author reply A86-7. *Low-level environmental lead exposure and children's intellectual function: an international pooled analysis*, Lanphear BP, Hornung R, Khoury J, Yolton K, Baghurst P, Bellinger DC, Canfield RL, Dietrich KN, Bornschein R, Greene T, Rothenberg SJ, Needleman HL, Schnaas L, Wasserman G, Graziano J, Roberts R.

Abstract – italics added:

“Lead is a confirmed neurotoxin, but questions remain about lead-associated intellectual deficits at blood lead levels < 10 microg/dL and whether lower exposures are, for a given change in exposure, associated with greater deficits. The objective of this study was to examine the association of intelligence test scores and blood lead concentration, especially for children who had maximal measured blood lead levels < 10 microg/dL. We examined data collected from 1,333 children who participated in seven international population-based longitudinal cohort studies, followed from birth or infancy until 5-10 years of age. The full-scale IQ score was the primary outcome measure. The geometric mean blood lead concentration of the children peaked at 17.8 microg/dL and declined to 9.4 microg/dL by 5-7 years of age; 244 (18%) children had a maximal blood lead concentration < 10 microg/dL, and 103 (8%) had a maximal blood lead concentration < 7.5 microg/dL. After adjustment for covariates, we found an inverse relationship between blood lead concentration and IQ score.

Using a log-linear model, we found a 6.9 IQ point decrement [95% confidence interval (CI), 4.2-9.4] associated with an increase in concurrent blood lead levels from 2.4 to 30 microg/dL. ***The estimated IQ point decrements associated with an increase in blood lead from 2.4 to 10 microg/dL, 10 to 20 microg/dL, and 20 to 30 microg/dL were 3.9 (95% CI, 2.4-5.3), 1.9 (95% CI, 1.2-2.6), and 1.1 (95% CI, 0.7-1.5), respectively.*** For a given increase in blood lead, the lead-associated intellectual decrement for children with a maximal blood lead level < 7.5 microg/dL was significantly greater than that observed for those with a maximal blood lead level > or = 7.5 microg/dL (p = 0.015). We conclude that environmental lead exposure in children who have maximal blood lead levels < 7.5 microg/dL is associated with intellectual deficits.

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#### Basis for the Linear Model

EPA-CASAC-07-007: EPA, Office of the Administrator Science Advisory Board.  
Subject: Clean Air Scientific Advisory Committee’s (CASAC) Review of the 2<sup>nd</sup> Draft Lead Human Exposure and Health Risk Assessments Document, September 27, 2007, Stephen L. Johnson.

#### Italics Added:

“Paragraph 6. Predicting IQ Changes Based on Concurrent Blood Lead Concentrations  
***The Panel recommends using the two-piece linear function for relating IQ alterations to current blood lead levels with a slope change or “hinge” point closer to 7.5 µg/dL*** than 10.82 µg/dL as used by EPA staff in the second draft exposure/risk assessments document. The higher value used by staff underestimates risk at lower blood Pb levels, where most of the population will be located. ***Epidemiologic data indicate that the slope of the line below 7.5 µg/dL is approximately minus three (-3) IQ decrements per 1 µg/dL blood lead*** and the vast majority of children in the U.S. have maximal baseline Pb blood levels below 7.5 µg/dL (Lanphear et al., EHP 2005; MMWR 2005). On a population level, the mean increase in blood lead concentration from airborne lead would generally be up to, but not exceeding, a blood lead concentration of 7.5 µg/dL. This approach should also account for sensitive subpopulations of children.”