Childhood Lead Toxicity
An Update

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Objectives

- Review the effects of lead exposure.
- Review treatment strategies.
- Review the current CDC guidelines.

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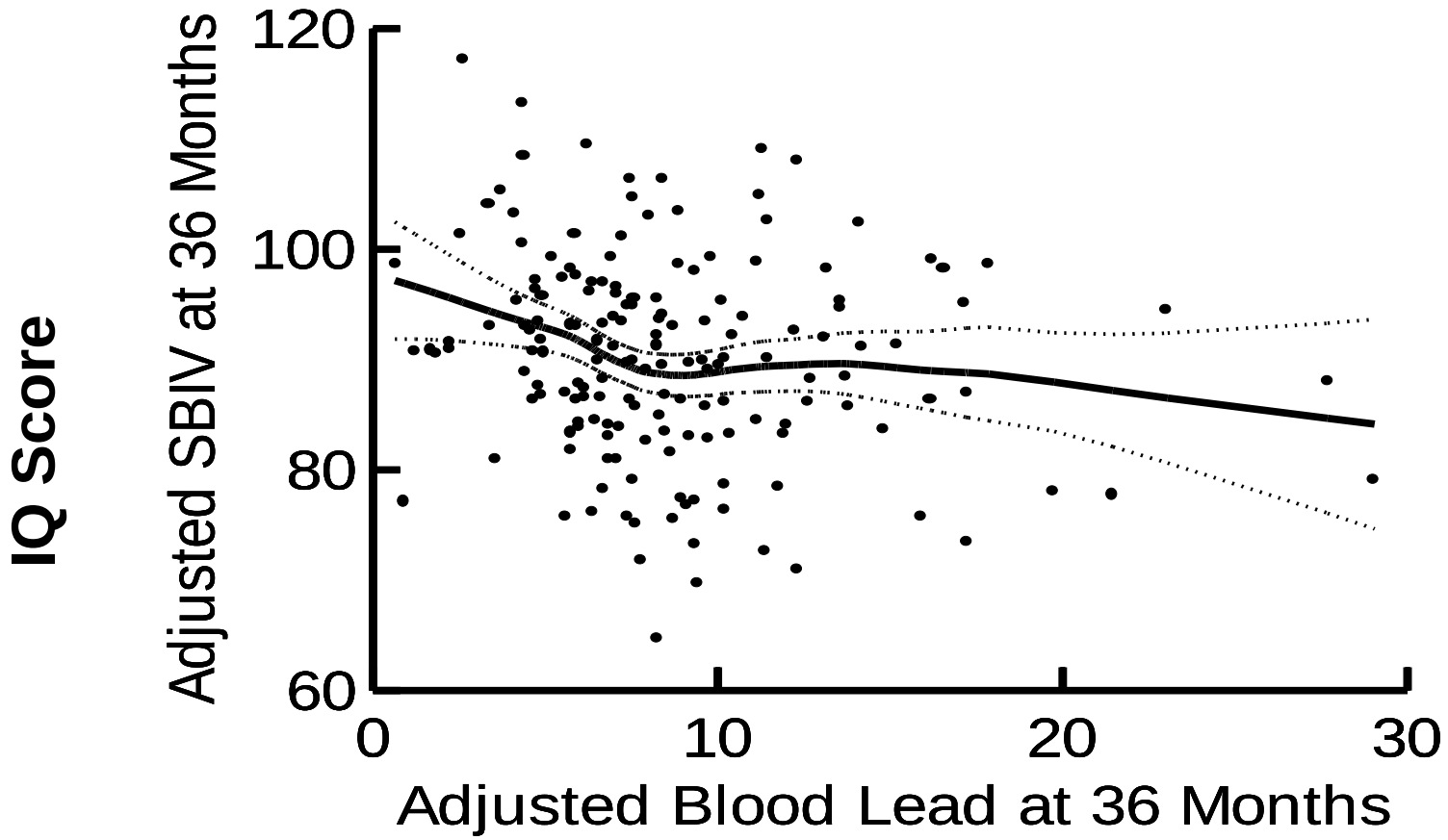
Intelligence

Estimated Loss in IQ for an Increase from 10 µg/dL to 20 µg/dL BPb

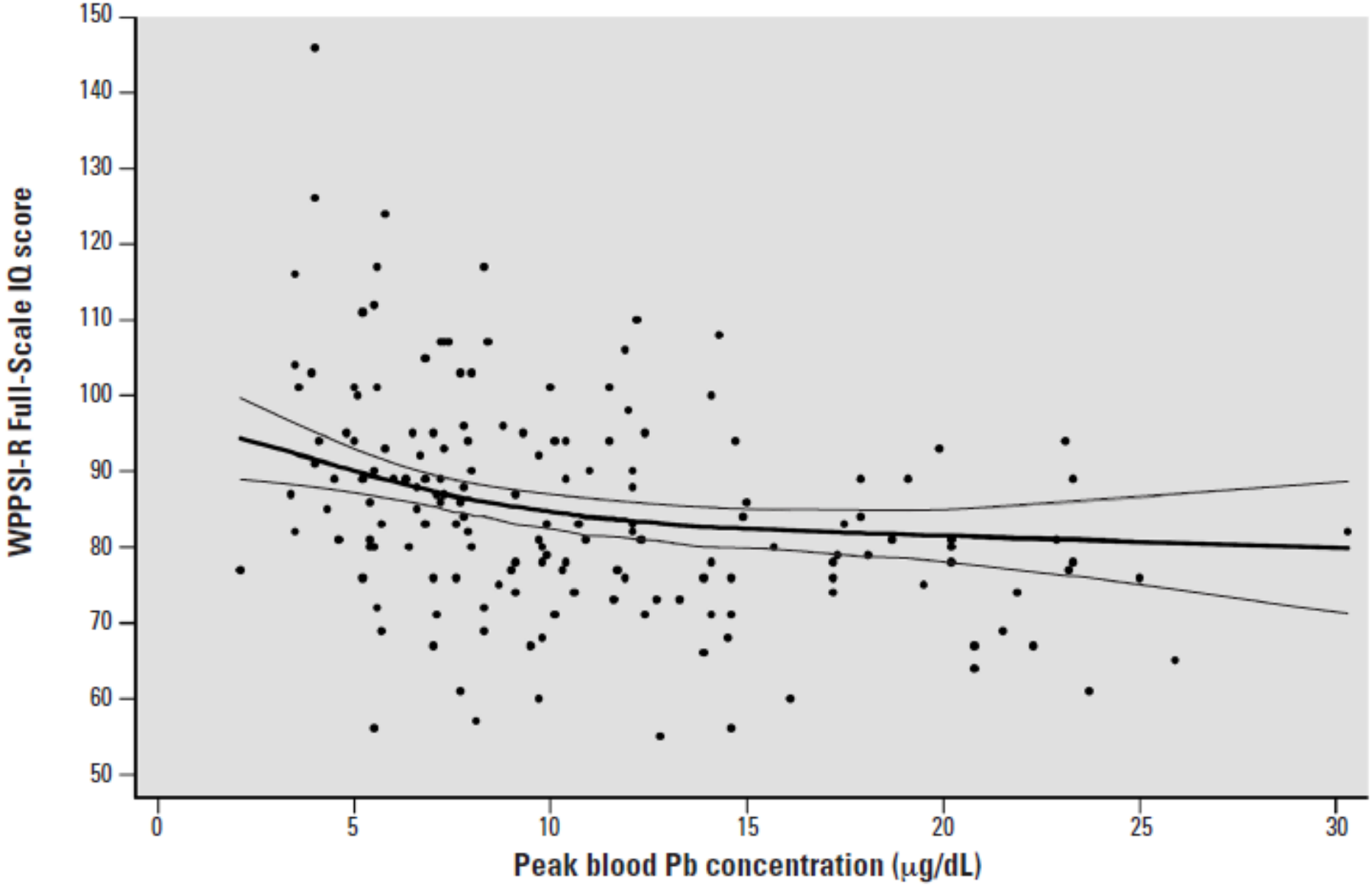
Study	Estimated Loss
•Hawk (1986)	2.6
•Hatzakis (1987)	2.7
•Fulton (1987)	2.6
•Bellinger (1992)	5.8
•Dietrich (1992)	1.3
•Baghurst (1992)	3.3
•Silva (1988)	1.5

Evidence that Lead Has Adverse Effects at Low Levels

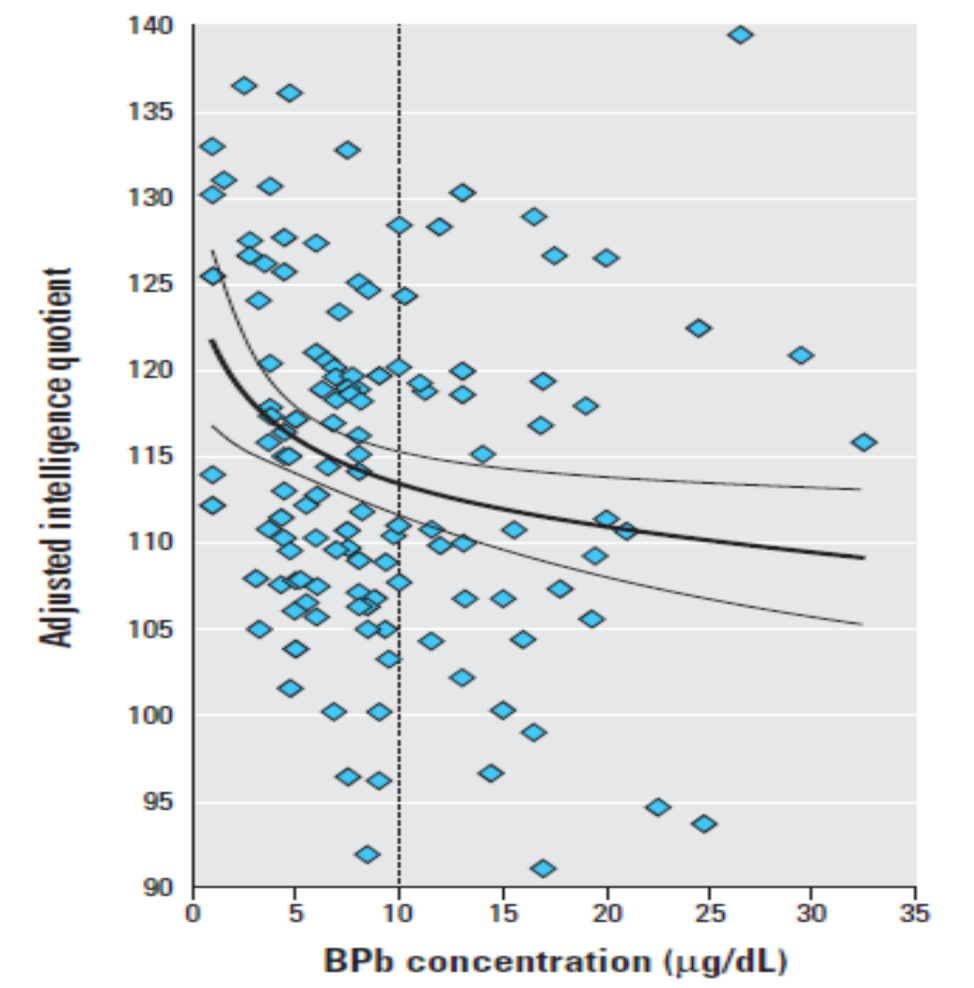


Canfield R. NEJM 2003;348:1517

Full-Scale IQ & Peak BLL



Third-trimester Maternal BPb on Full Scale IQ at age 8 years

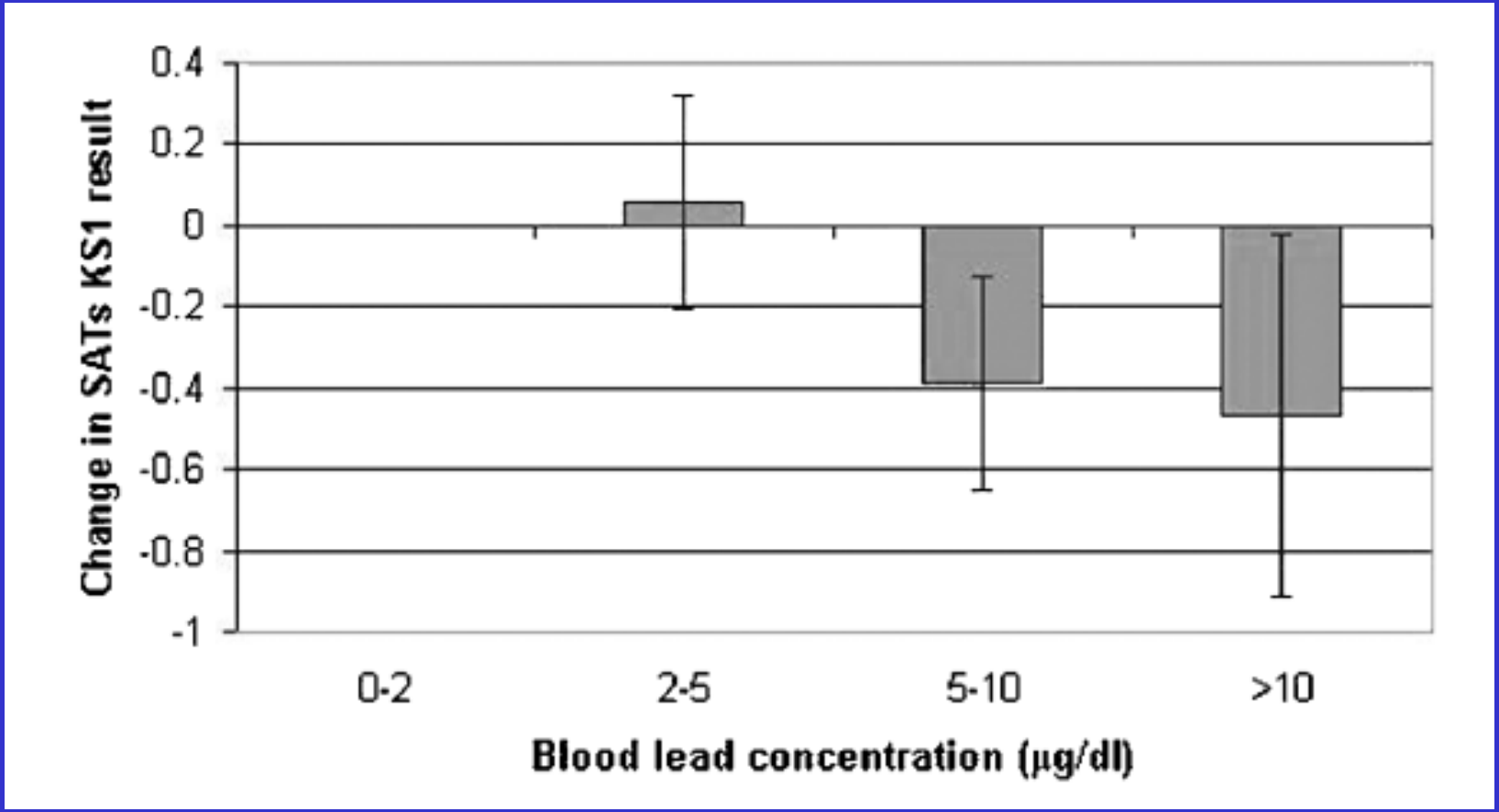


Learning Disabilities

Non-IQ Cognitive Effects of Lead

Study	Outcome	Odds Ratio
Needleman, 1990	Reading Disability	5.8
Lyngbye, 1990	Reading Disability	4.3
Ferguson, 1997	Reading Delay	3.4

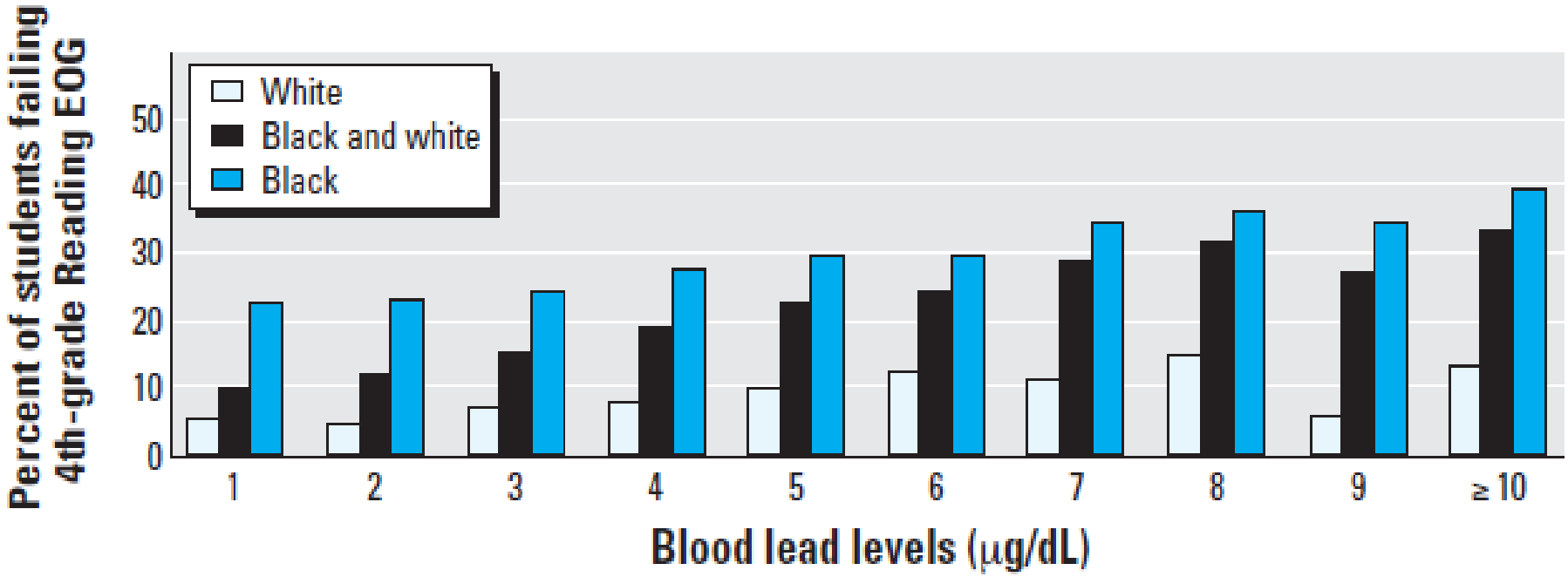
Lead-Associated Effect on Writing in School-age Children



SATs KS1 – Standard Assessment Tests, Key Stage 1

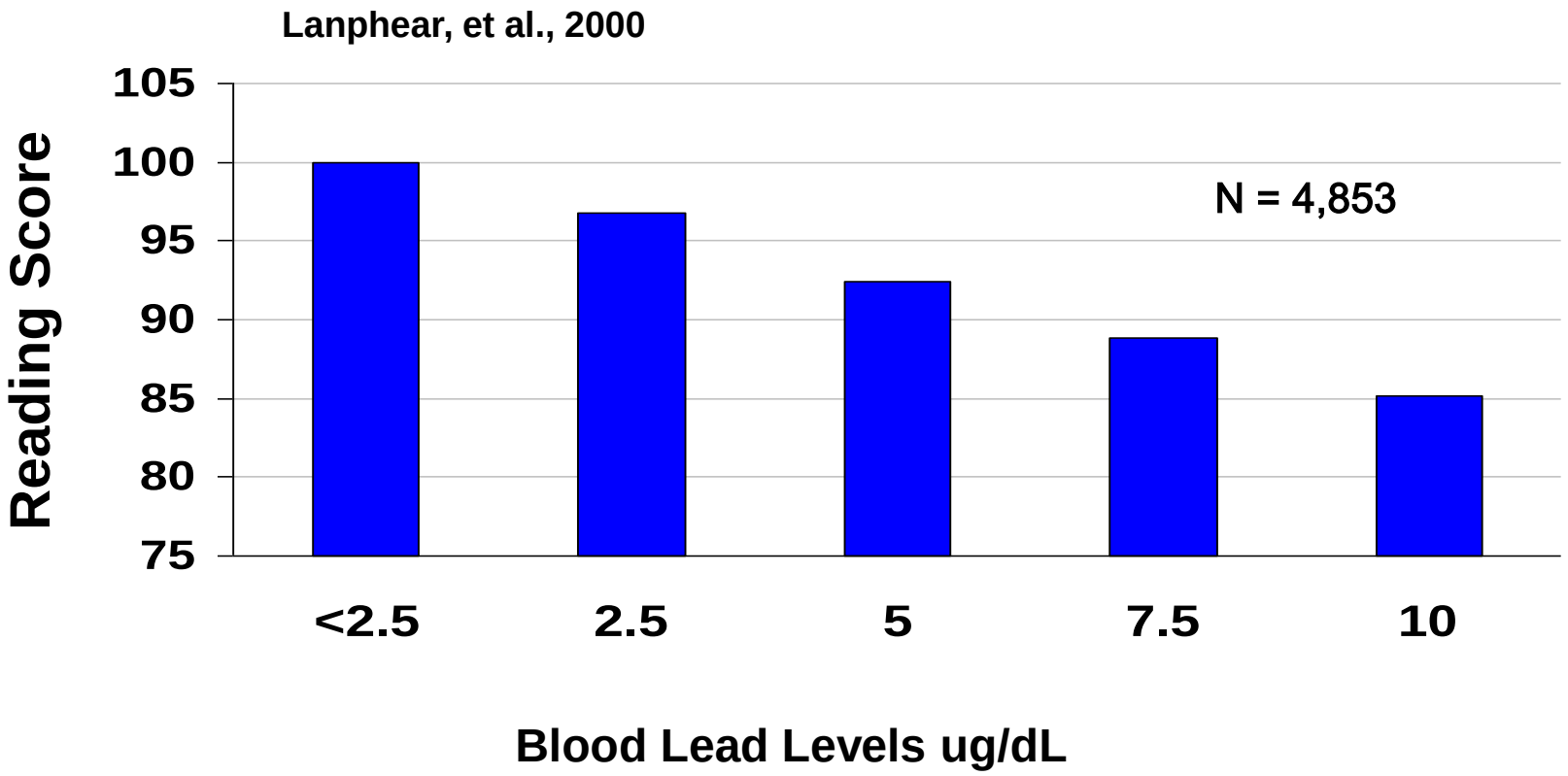
Chandramouli L, et al. Arch Dis Child. 2009.

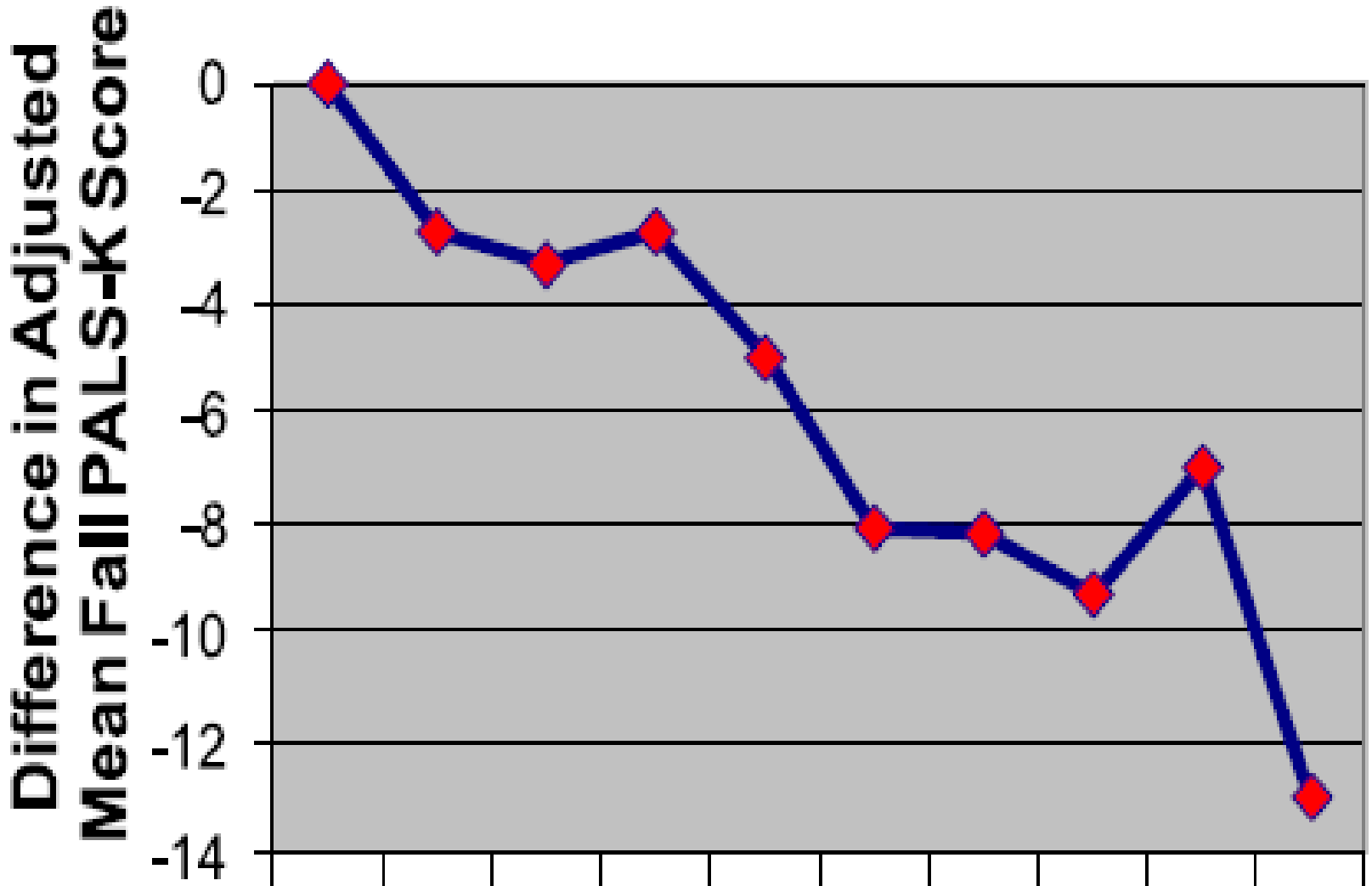
Lead-Associated Effect on Reading in School-age Children



Miranda ML, et al. Environ Health Perspect. 2007

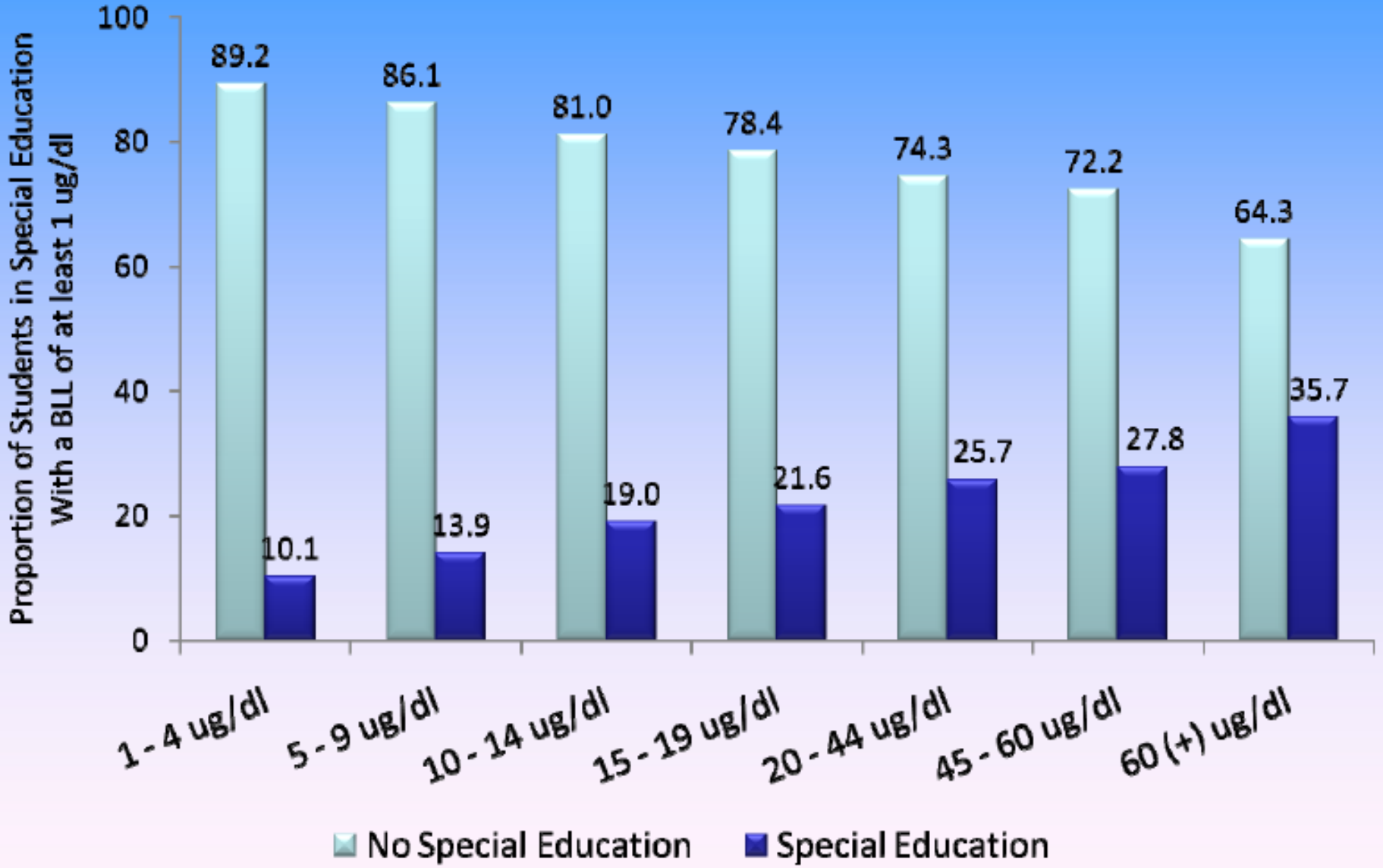
Lead-Associated Reading Deficits in U.S. Children: NHANES-III





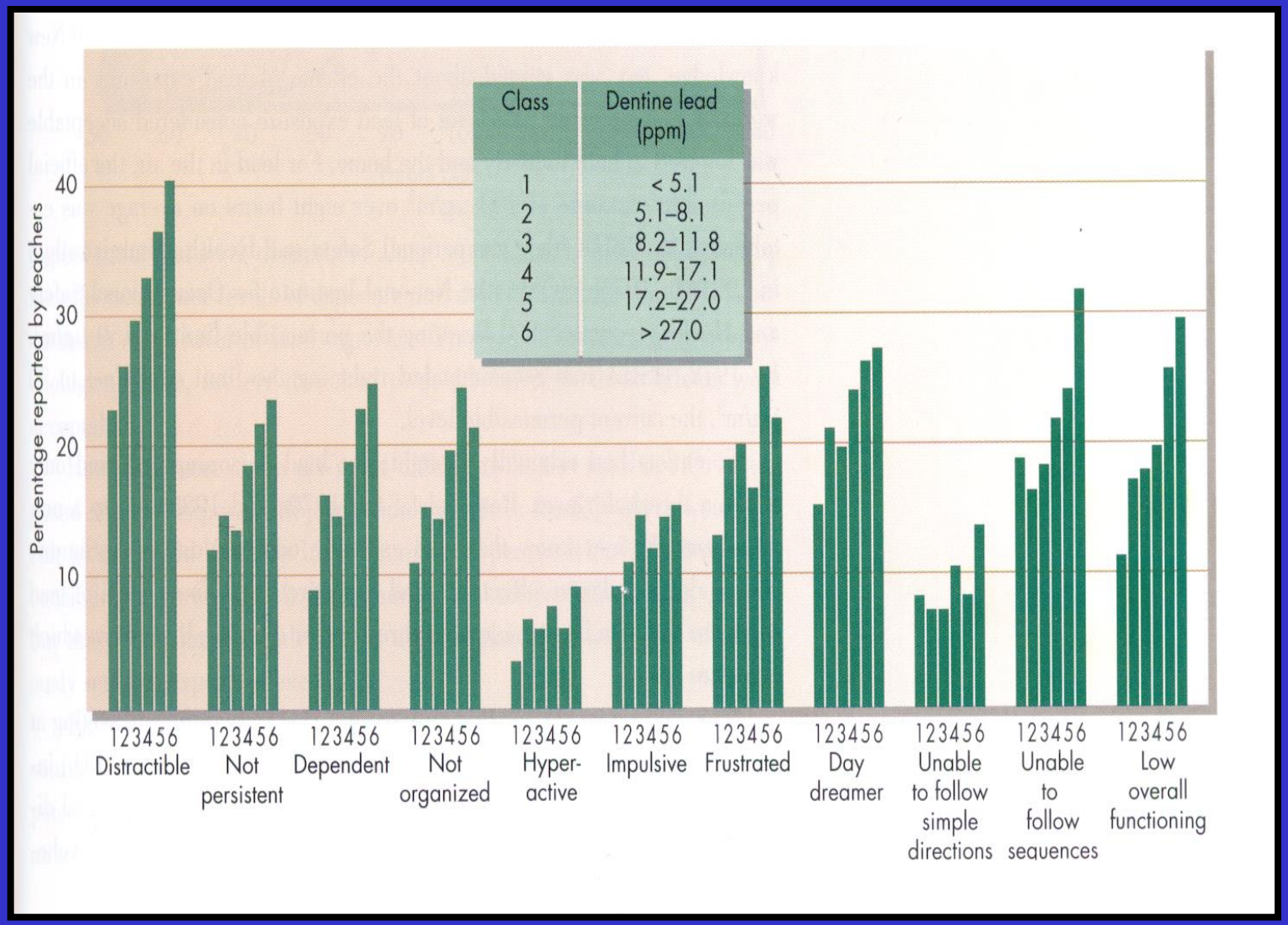
GM BLL Category	1	2	3	4	5	6	7	8	9	10+
Difference in Adjusted Mean Fall PALS-K Score	Ref.	-2.7	-3.3	-2.7	-5	-8.1	-8.2	-9.3	-7	-13

Special Education Status by Blood Lead Level



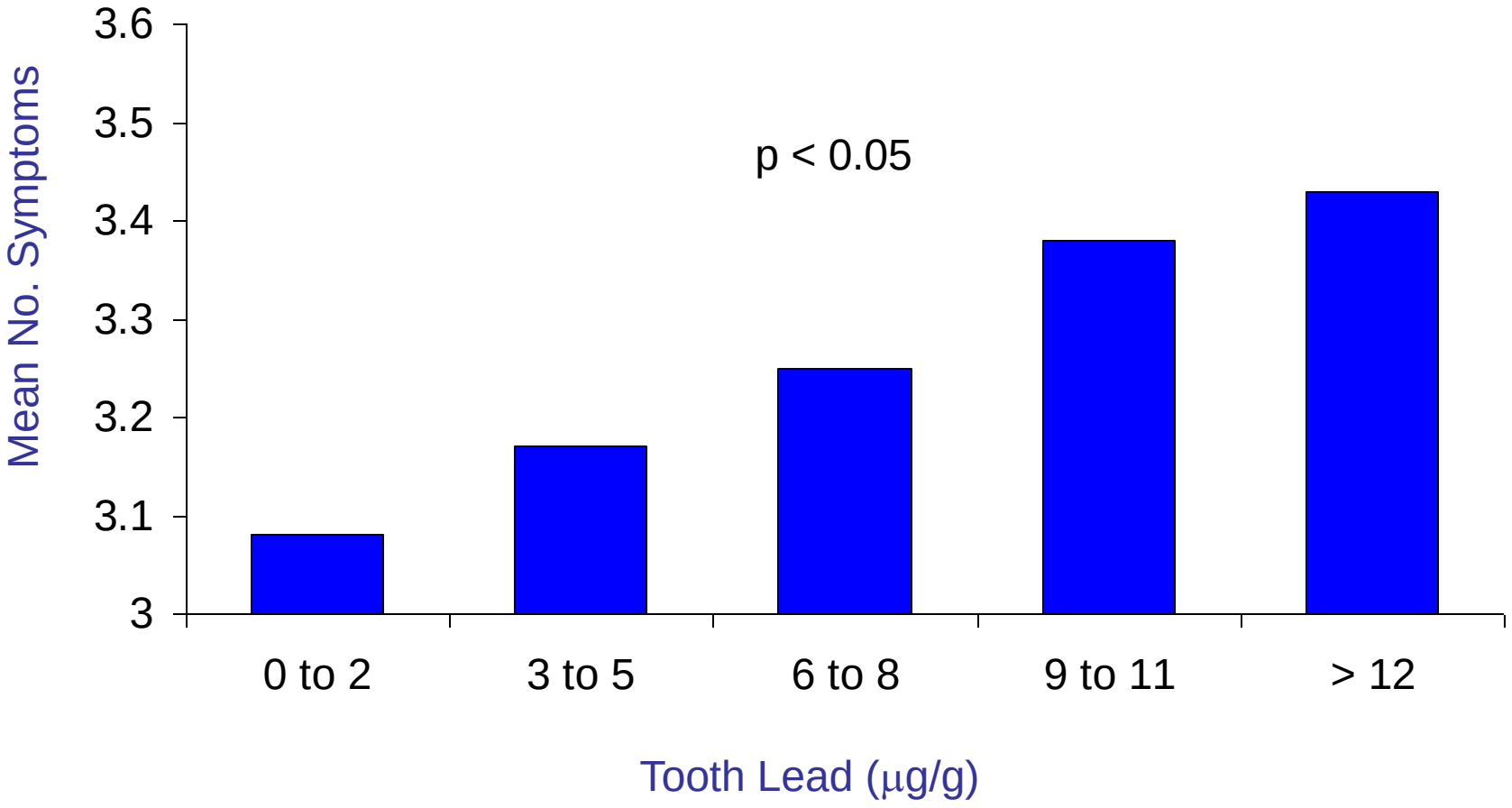
Attention

Lead-Associated Behavioral and Emotional Problems in School-age Children

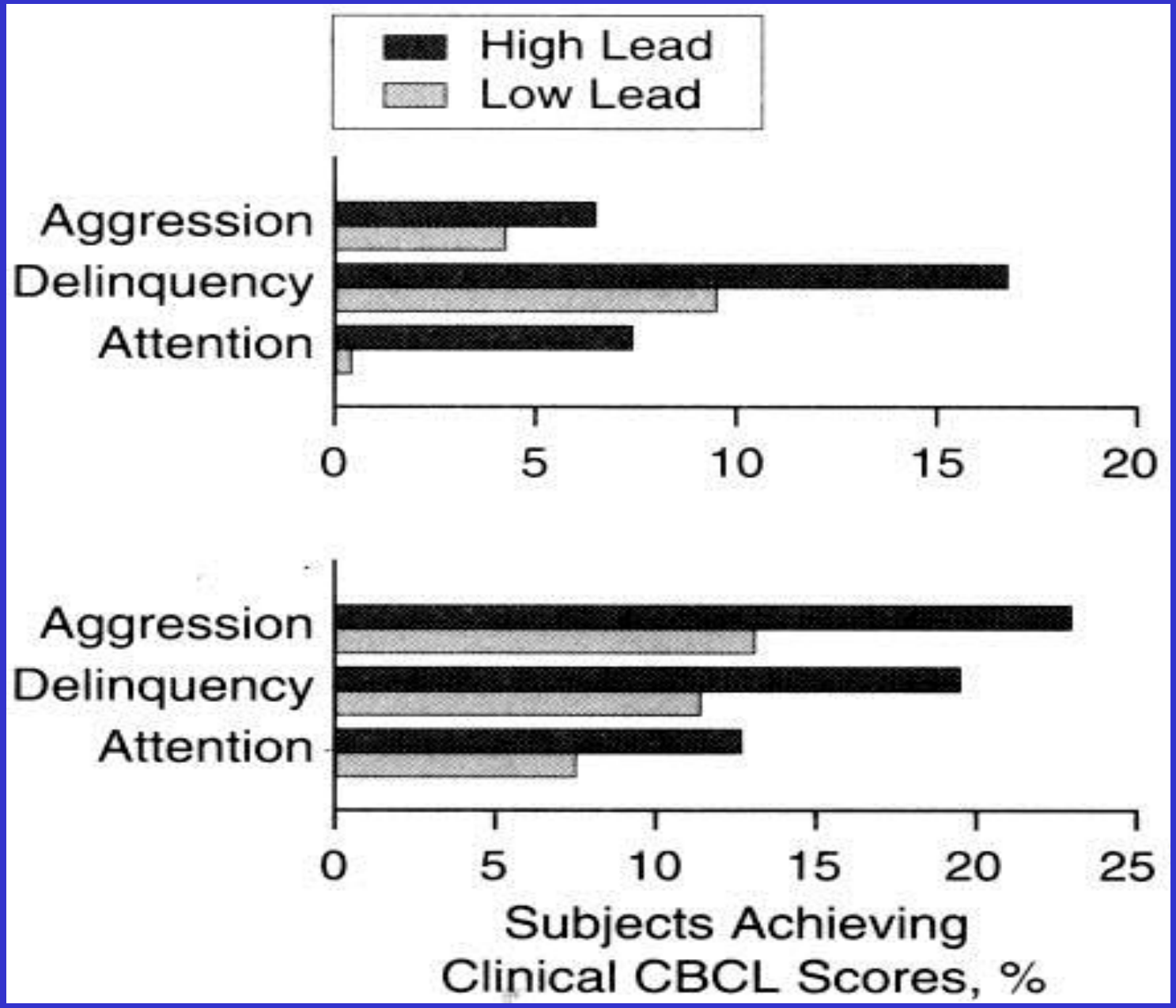


Needleman HL, et al. N Engl J Med 1979;300:689-95.

Mean Number of Symptoms of Inattention and Restlessness by Tooth Lead (μg/g)

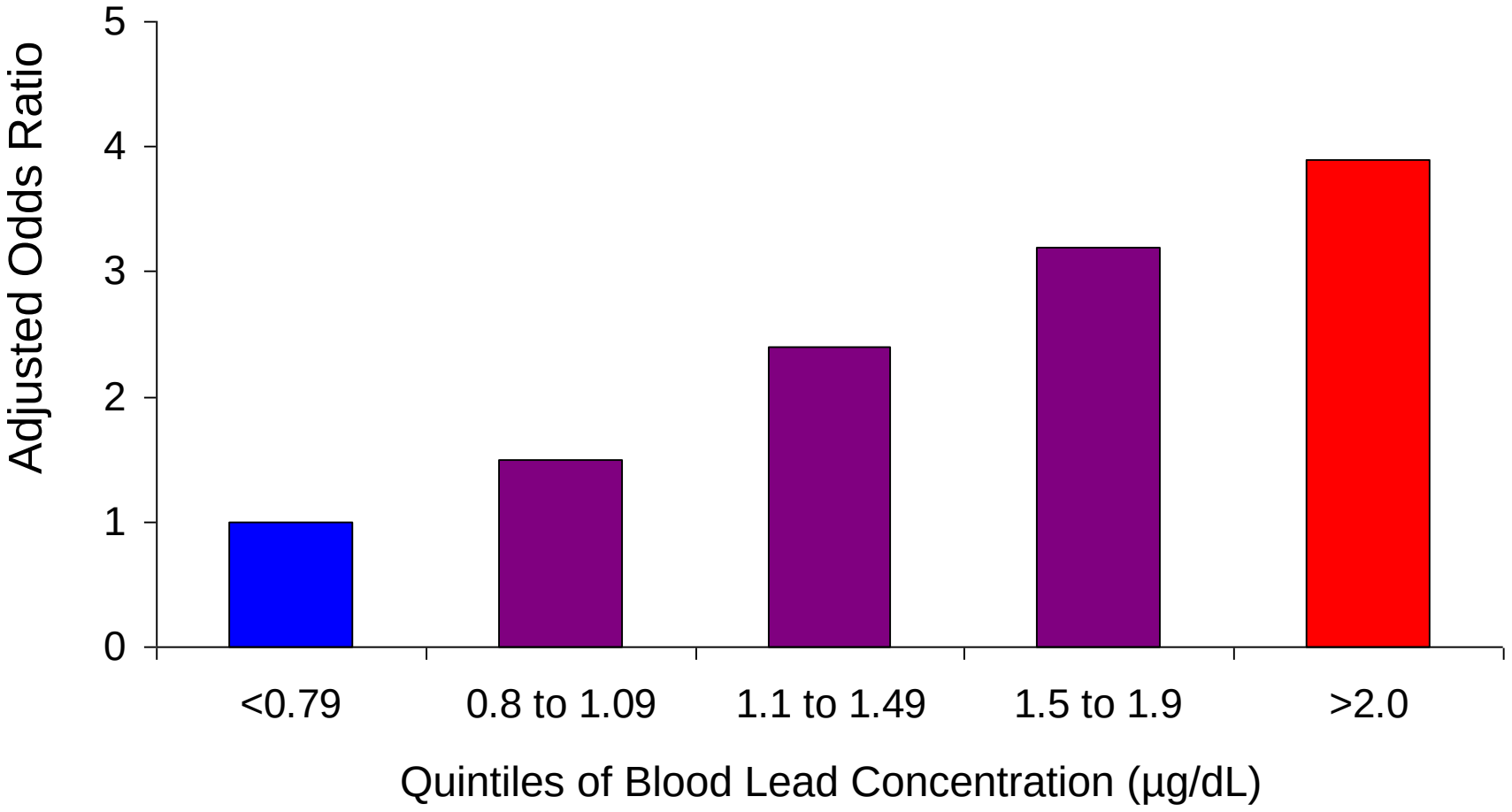


Fergusson DM, et al. J Child Psychol Psychiatry 1993:34:215-227.



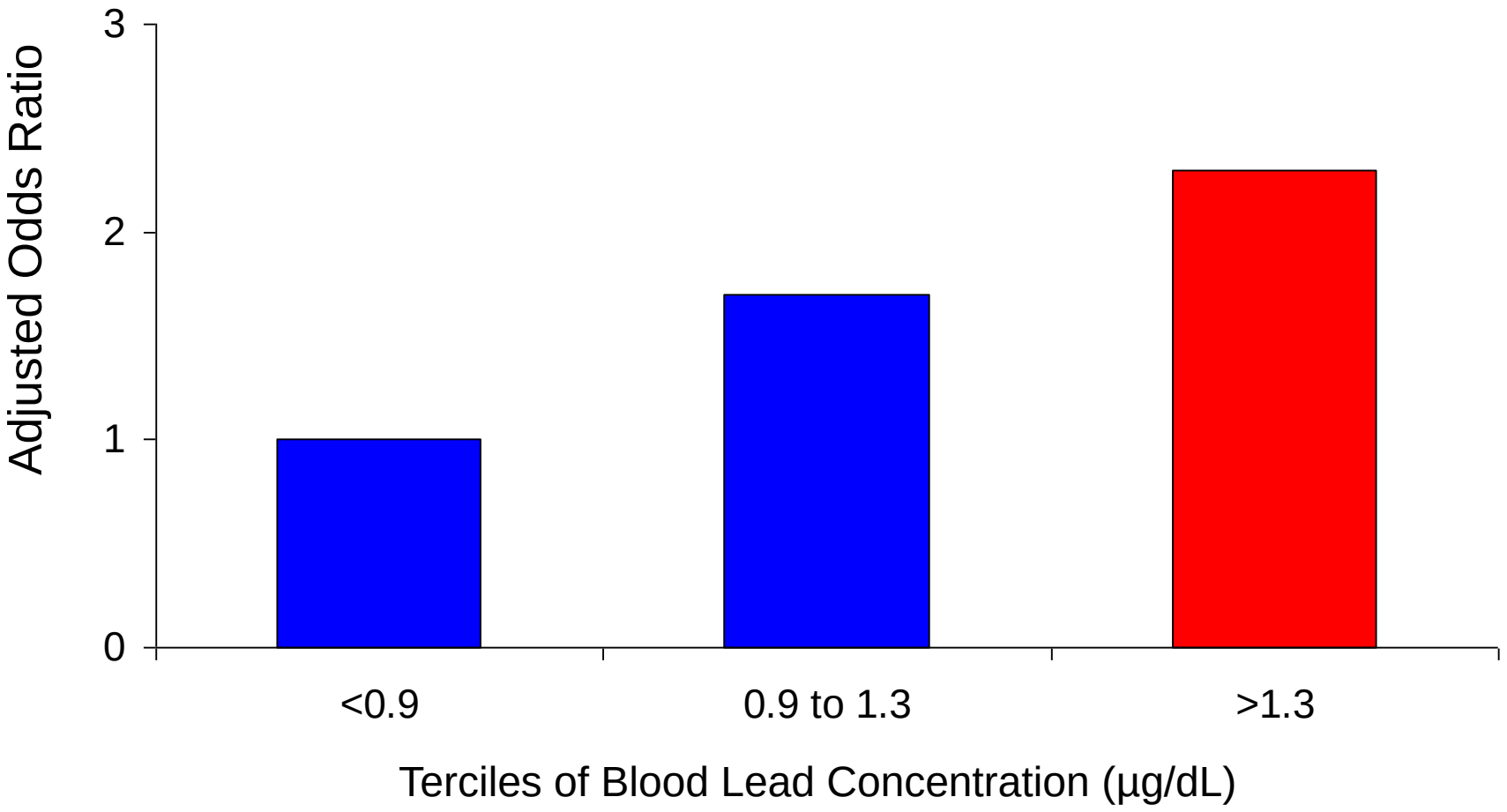
Needleman HL. JAMA. 1996;275(5):363-369

Risk of ADHD by Blood Lead Levels in US Children, 4 to 15 years, NHANES 1999-2002



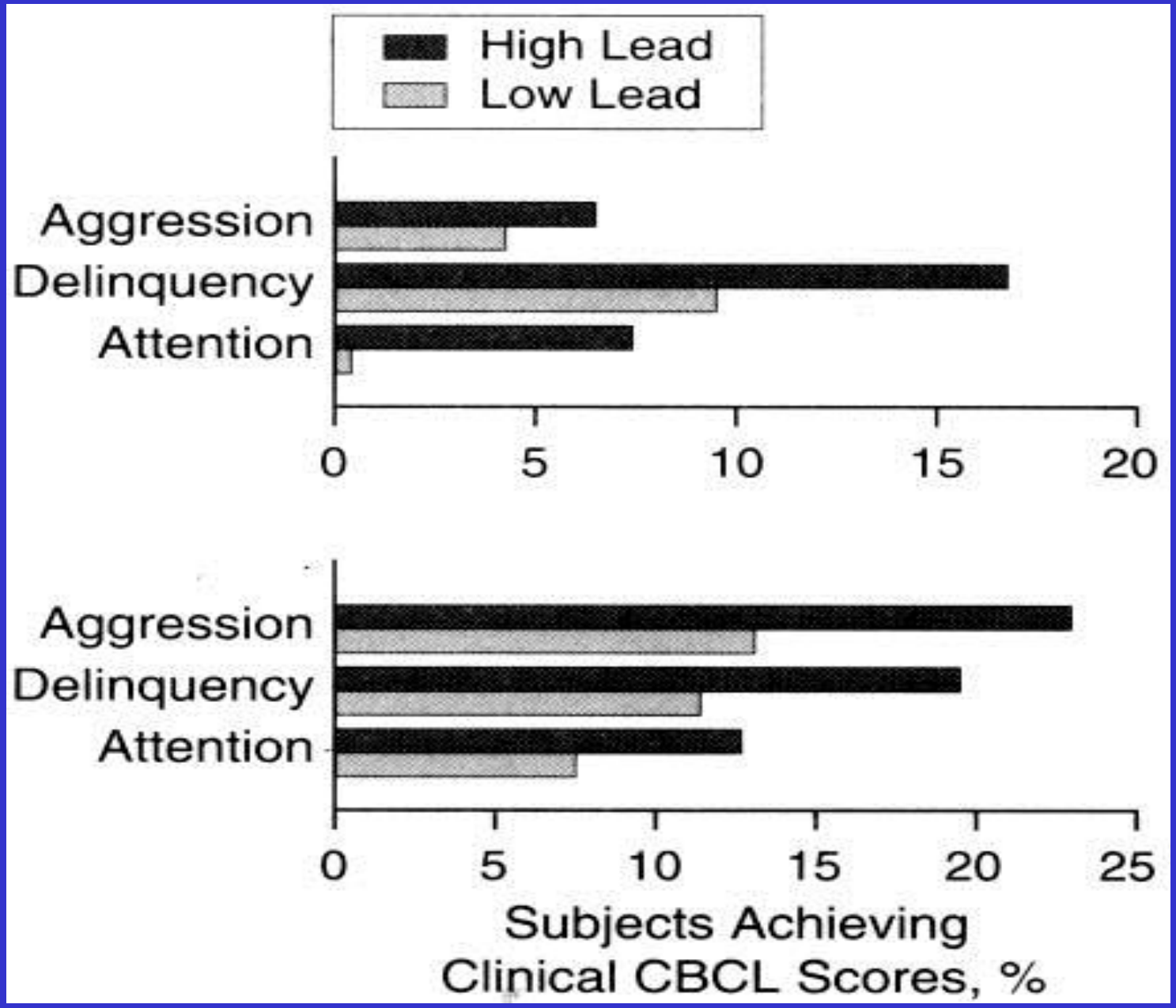
Adjusted for child's age, sex, race and ethnicity, preschool attendance, serum ferritin, prenatal tobacco exposure and health insurance status.

Odds of ADHD by Blood Lead Levels in US Children, 8 to 15 years, NHANES 2001-2004



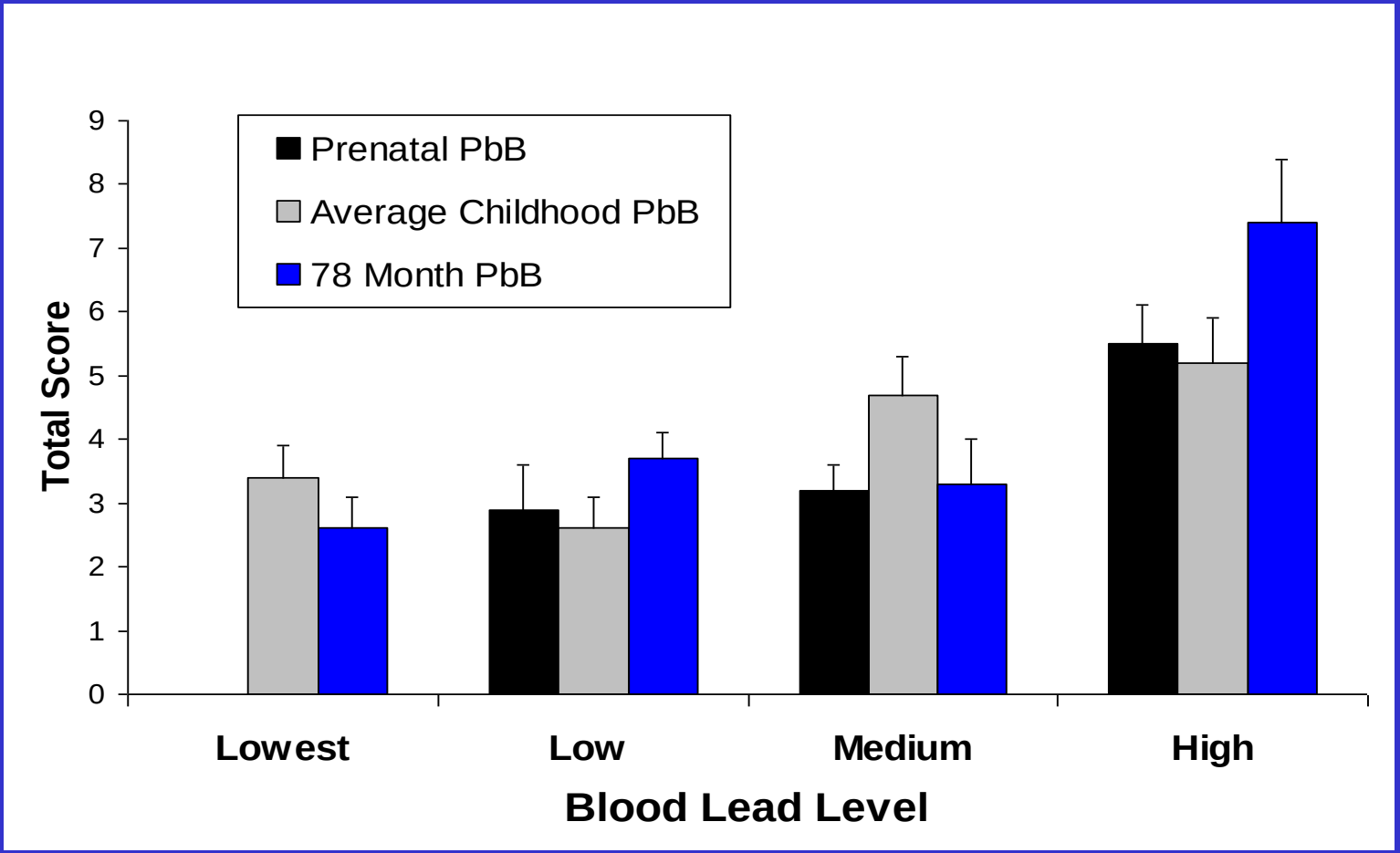
Froehlich T, et al Pediatrics. 2009;124:e1054-e1063

Anti-Social and Violent Behavioral



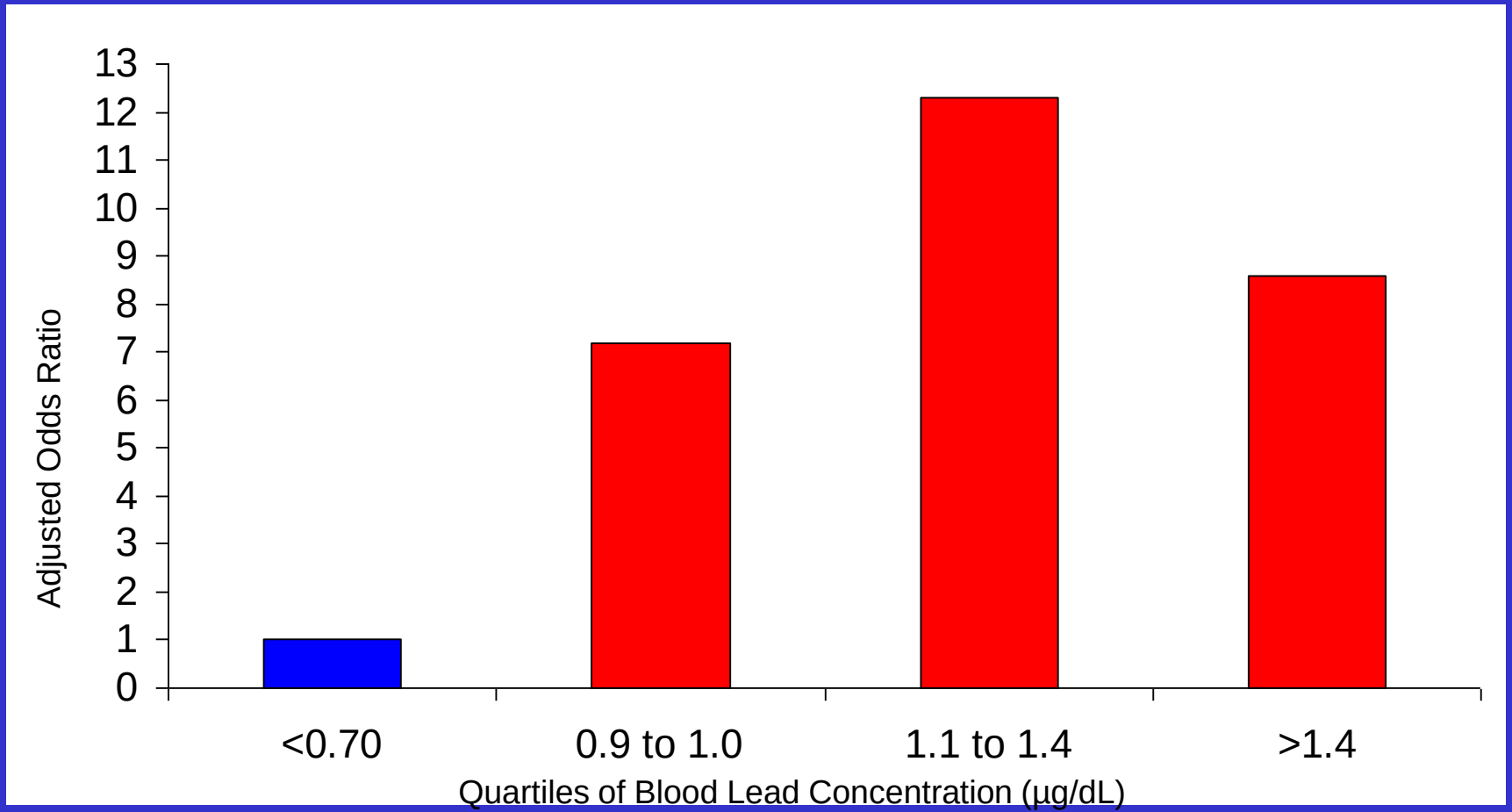
Needleman HL. JAMA. 1996;275(5):363-369

Association of Blood Lead Levels and Delinquent Behaviors in Adolescents



Dietrich KN. Neurotox Teratol 2001;23; 511-518.

Risk of Conduct Disorder by Blood Lead Level in US Children, 8 to 15 years, NHANES 2001-2004



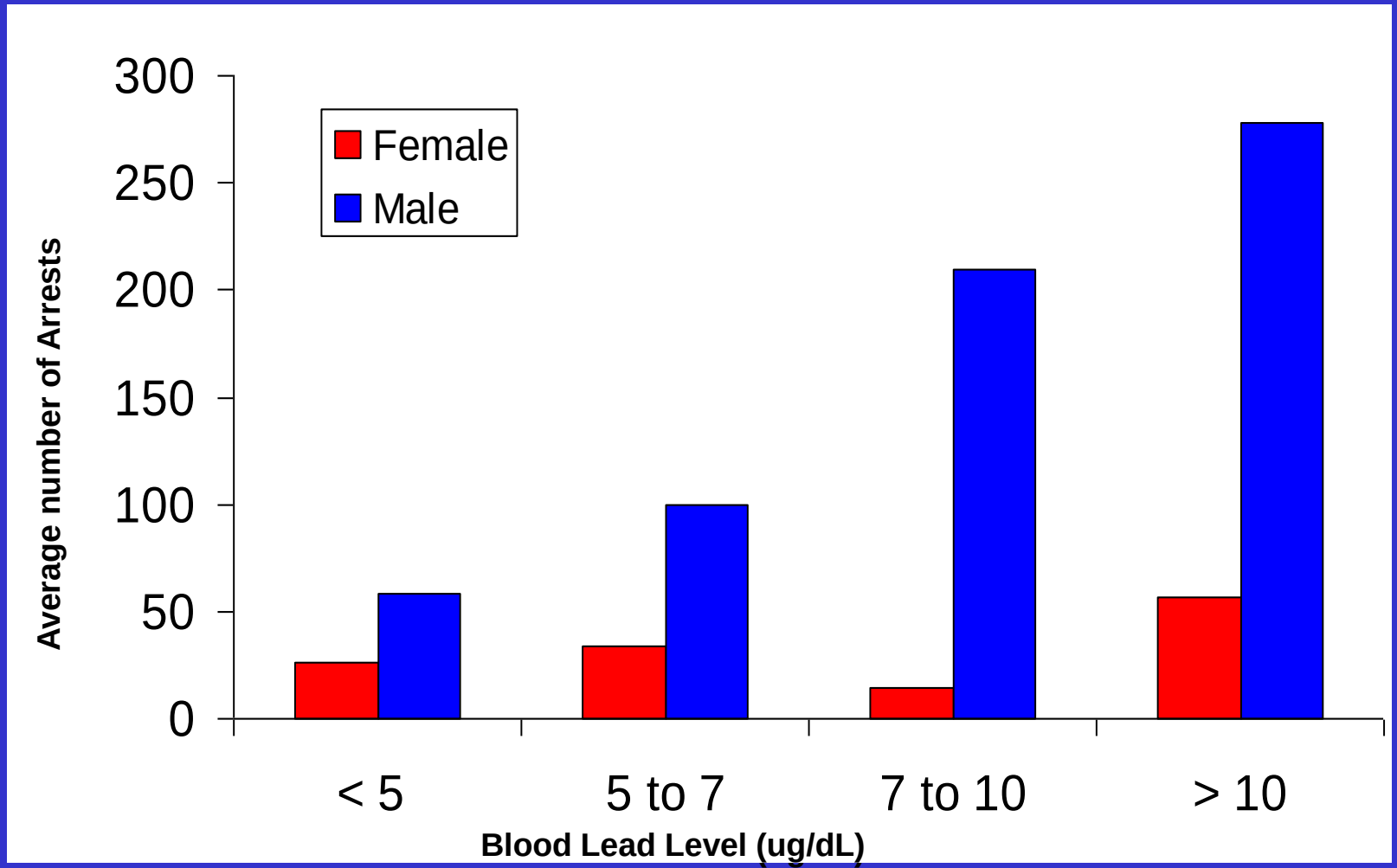
Braun JM. Environ Health Perspect. 2008;116:956–962

Number of Convictions by Dentine Lead Level

	Lead levels (µg/g)					Regression parameters*		
Outcome	0–2	3–5	6–8	9–11	12+	B	SE	p Value
Adjusted mean number of violent/ property convictions, ages 14–21†	0.24	0.39	0.63	1.03	1.67	0.49	0.17	0.005
Adjusted mean number of self-reported/ violent/ property offences, ages 14–21‡	5.91	7.22	8.81	10.76	13.13	0.20	0.10	0.047

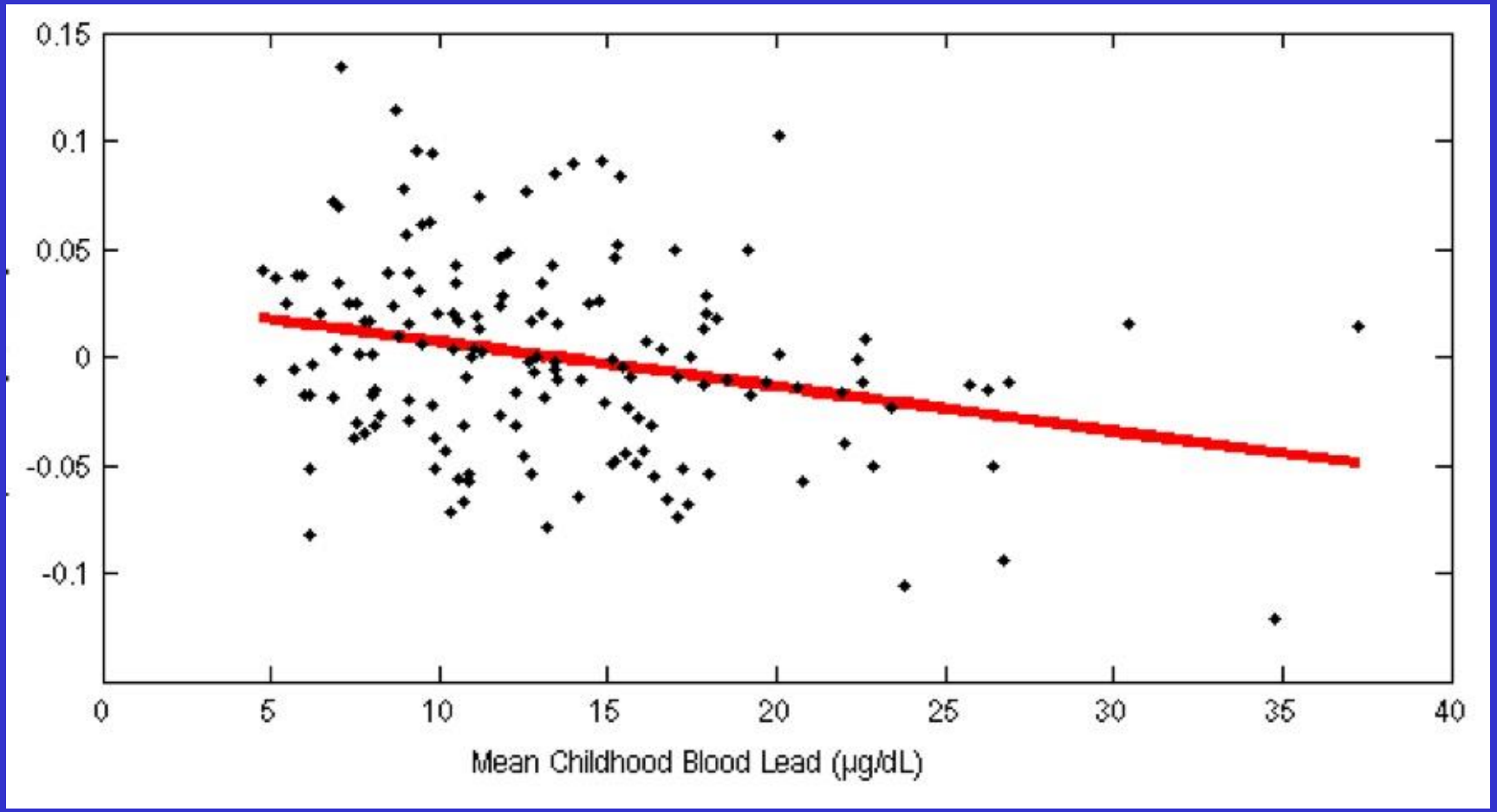
Fergusson DM. J Epidemiol Community Health 2008;62:1045–1050.

Number of Criminal Arrests by Blood Lead Level and Sex



Wright JP. PLoS Medicine 2008;5:e101.

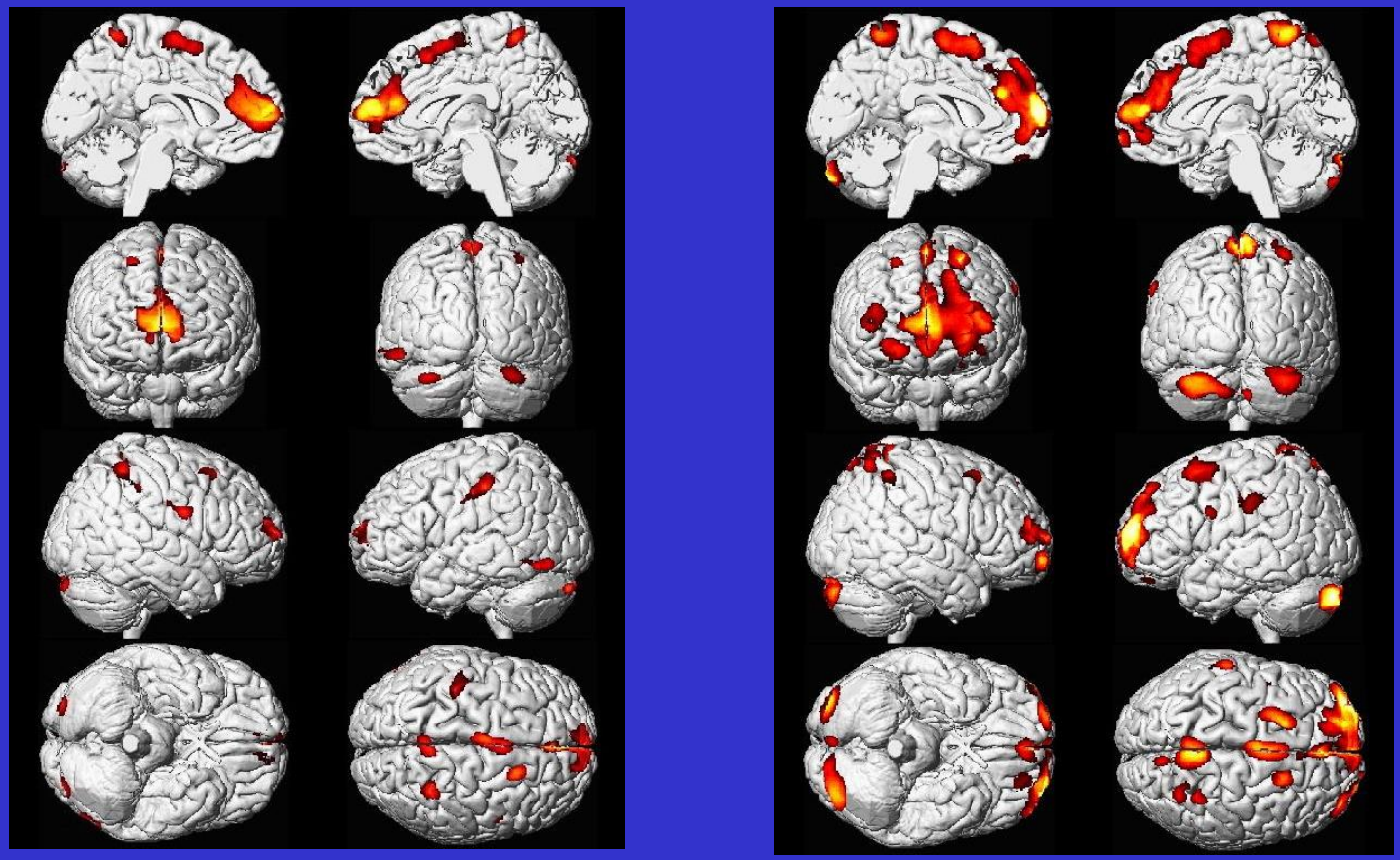
Lead Associated Gray Matter Loss in Adult Brain



Cecil K, PLoS Medicine.

Lead Associated Gray Matter Loss in Adult Brain

Average Childhood Blood Lead **Six-Year Blood Lead**



Cecil K, PLoS Medicine. 2008;5:e112.

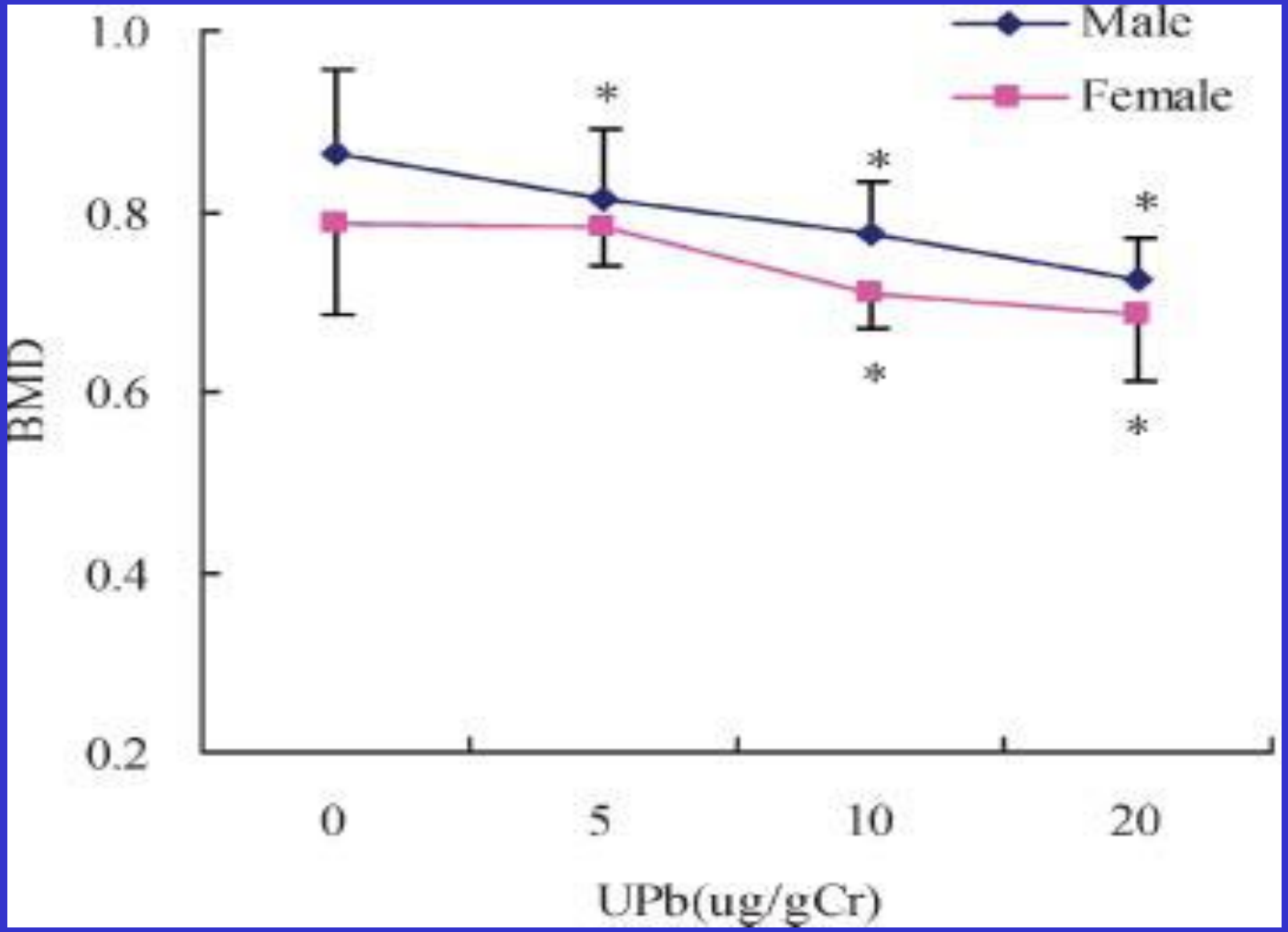
Osteoporosis

Lead and Bone Mineral Density NHANES Analysis

Measure	Female		Male	
	White	African-American	White	African-American
Adjusted mean (SE) BMD (g/cm^2)[a]				
Lowest	0.789 (0.006)	0.898 (0.010)	0.961 (0.007)	1.036 (0.011)
Middle	0.776[b] (0.006)	0.882 (0.009)	0.944[c] (0.006)	1.023 (0.010)
Highest	0.771[b] (0.007)	0.873 (0.012)	0.934[c] (0.009)	1.011 (0.013)

Campbell JR. Environ Health Perspect. 2007;115:1018-1022.

Lead and Bone Mineral Density Occupationally Exposed Chinese



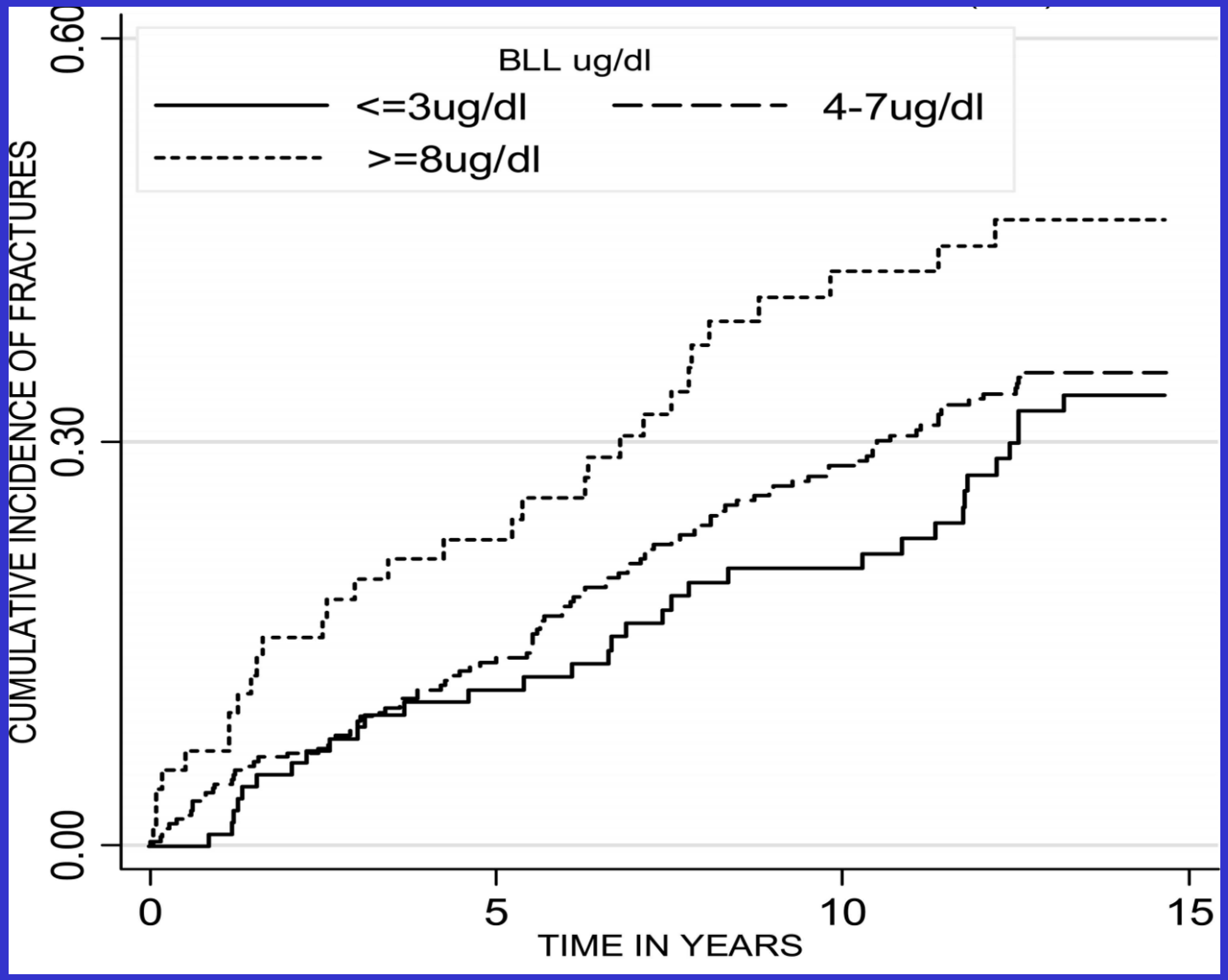
Sun Y. Am J Ind Med. 2008;51:436-442

Lead and Bone Mineral Density Study of Osteoporotic Fractures

	Low	*Medium*	*High*
Level (μg/dl)	≤3	4–7	≥8
N = 533	*N* = 122	*N* = 332	*N* = 79
BMD (g/cm^2)			
Total hip [mean (SD)]	0.77 (0.13)	0.76 (0.13)	0.72 (0.12)
Femoral neck [mean (SD)]	0.65 (0.11)	0.66 (0.12)	0.62 (0.09)
Calcaneus [mean (SD)]	0.41 (0.09)	0.42 (0.09)	0.39 (0.09)

Khalil N, et al. J Bone Miner Res 2008;23:1417–1425

Lead and Fracture Incidence Study of Osteoporotic Fractures

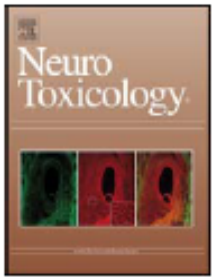


Khalil N, et al. J Bone Miner Res 2008;23:1417–1425.

Cognition in Adults

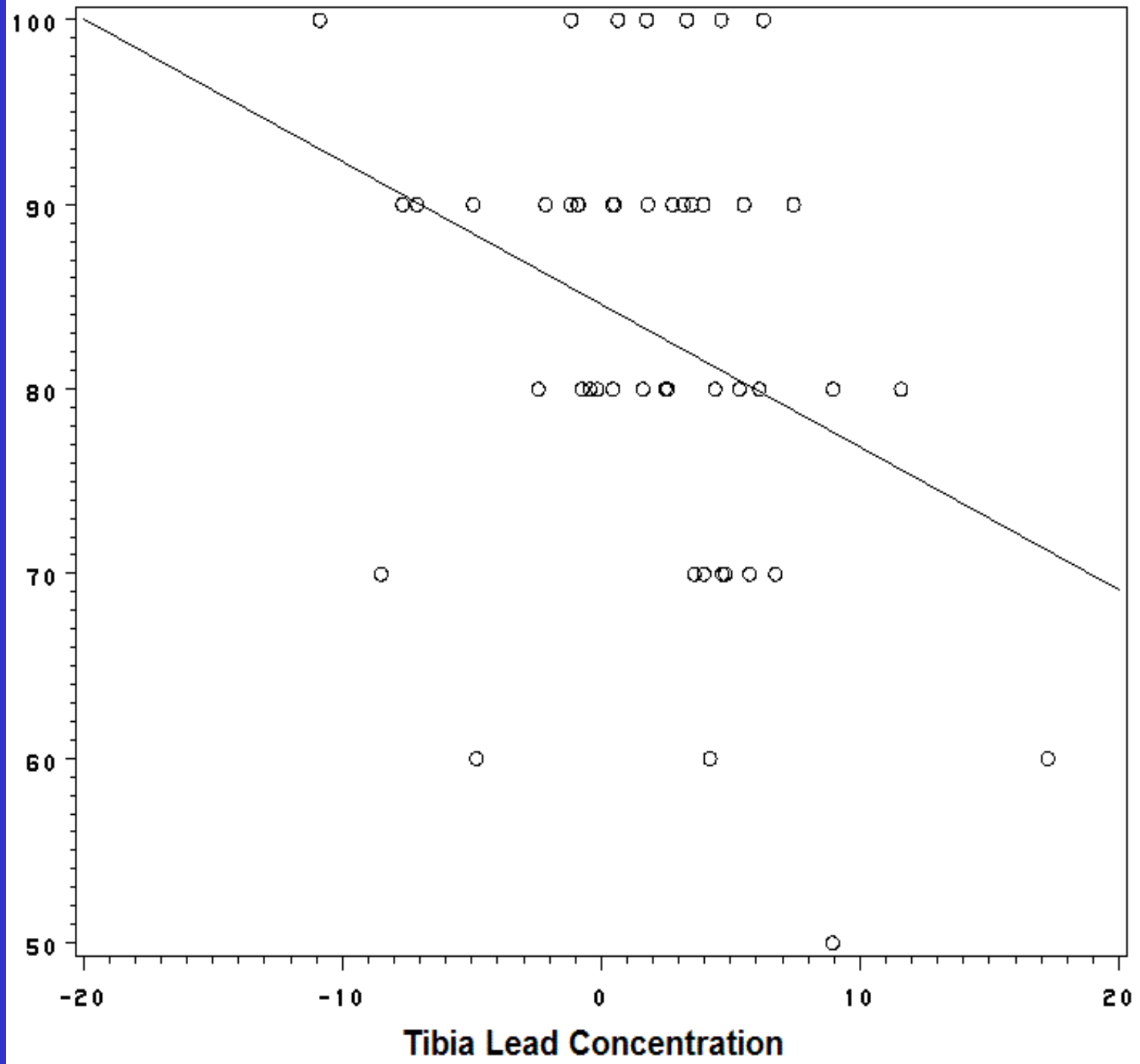
Contents lists available at ScienceDirect

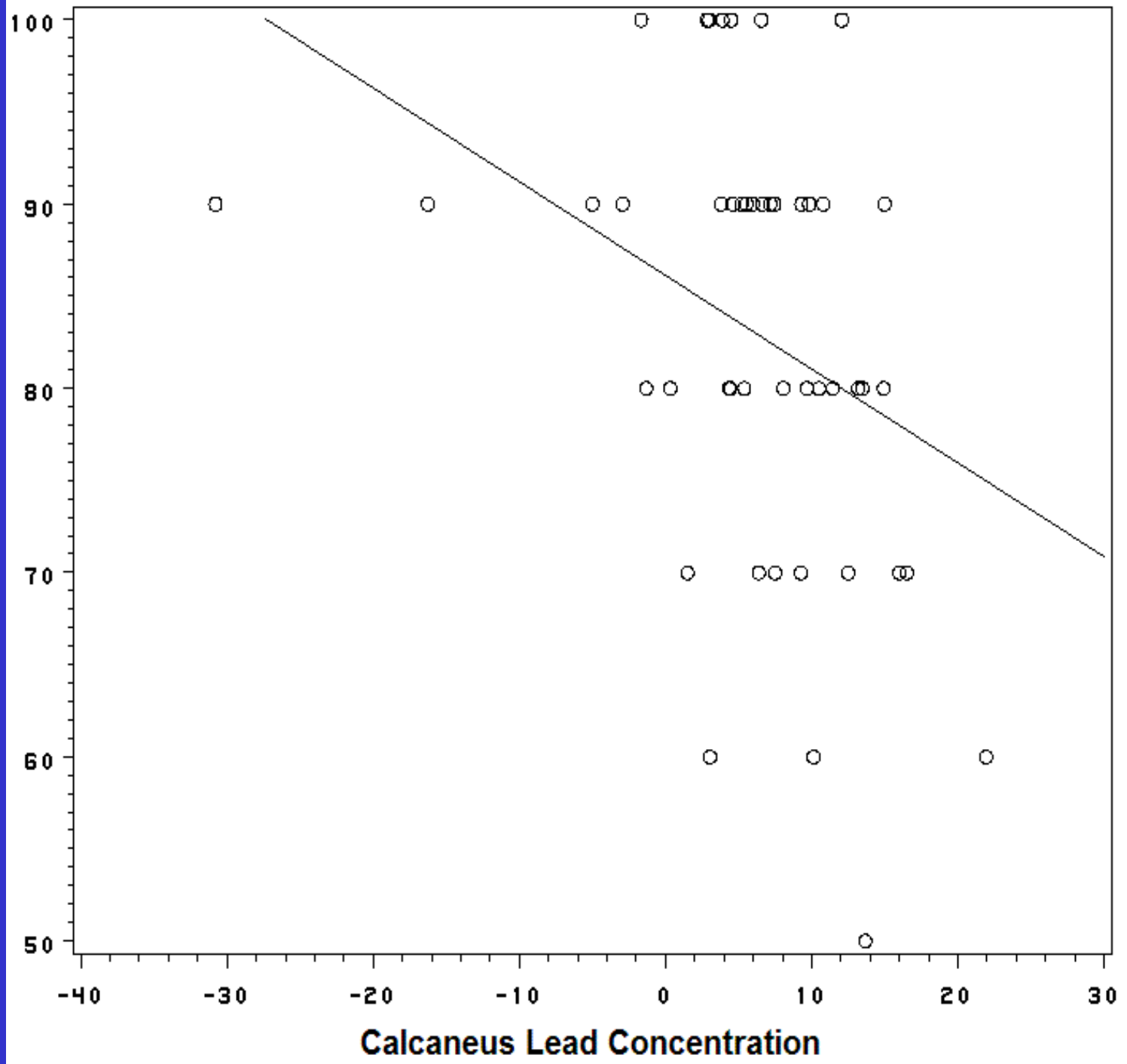
NeuroToxicology

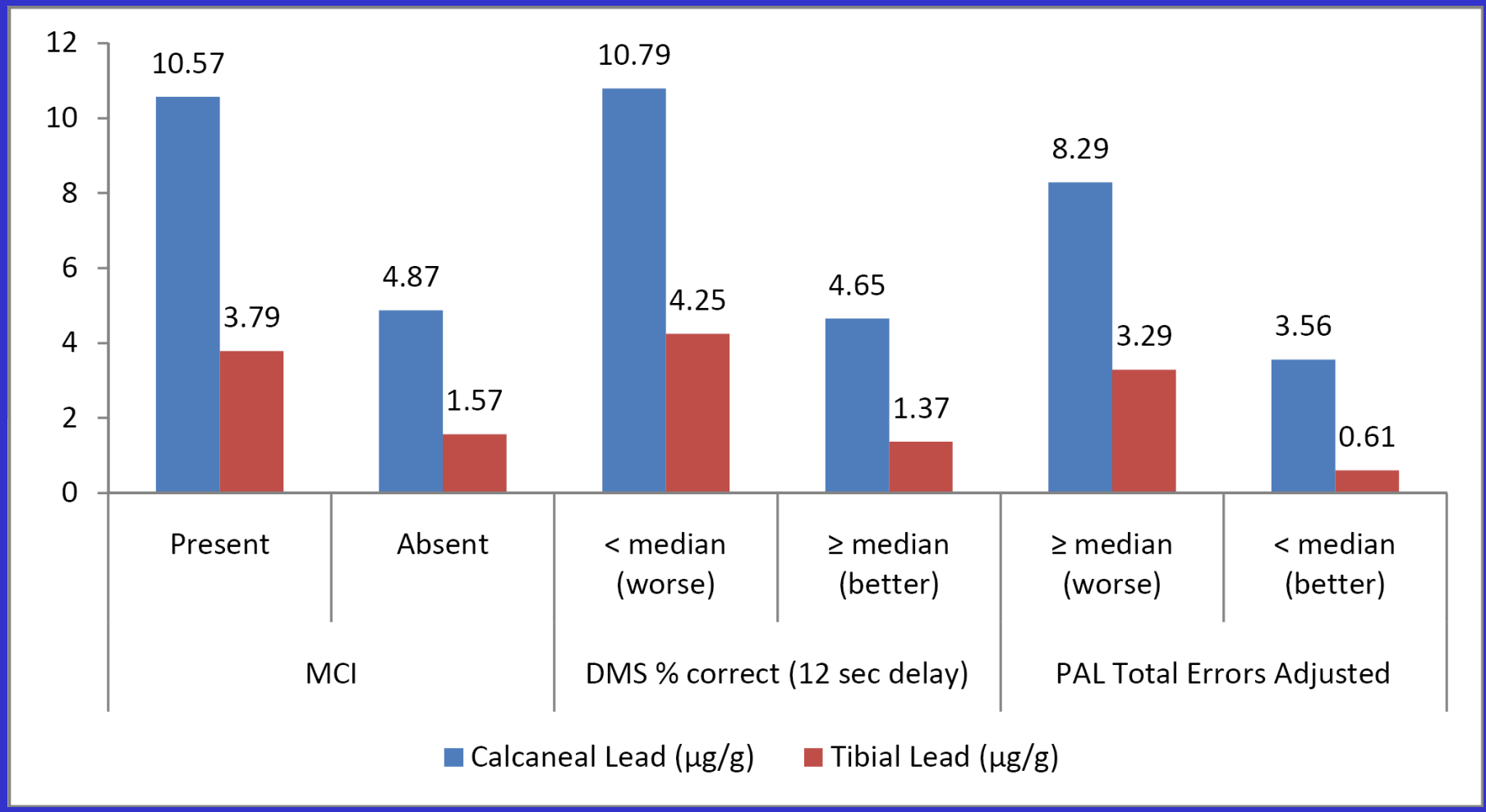


Bone lead levels are associated with measures of memory impairment in older adults

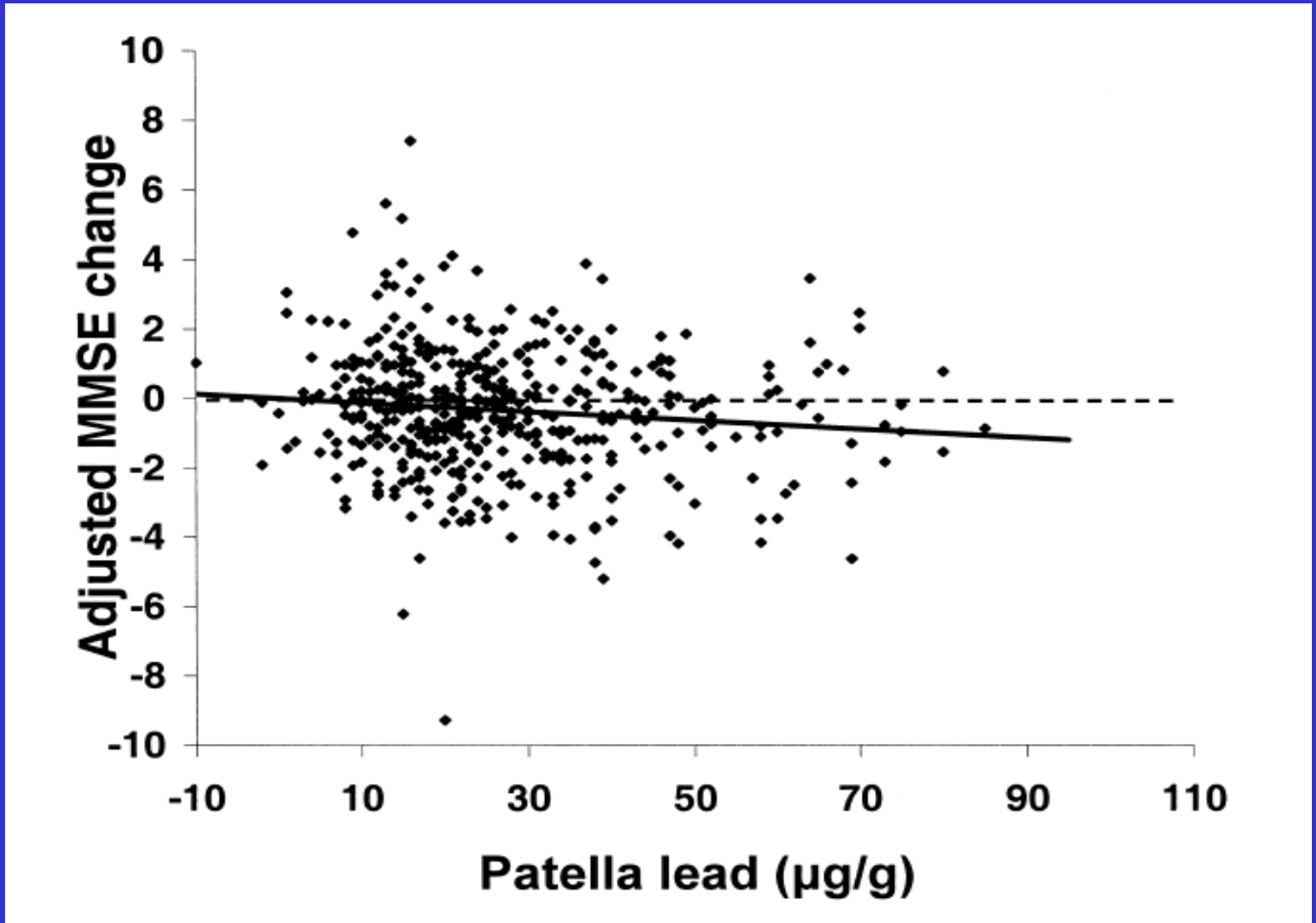
Edwin van Wijngaarden [a,b,*], James R. Campbell [c], Deborah A. Cory-Slechta [b]


100
90
80
70
60
50
-20
-10
0
10
20
Tibia Lead Concentration

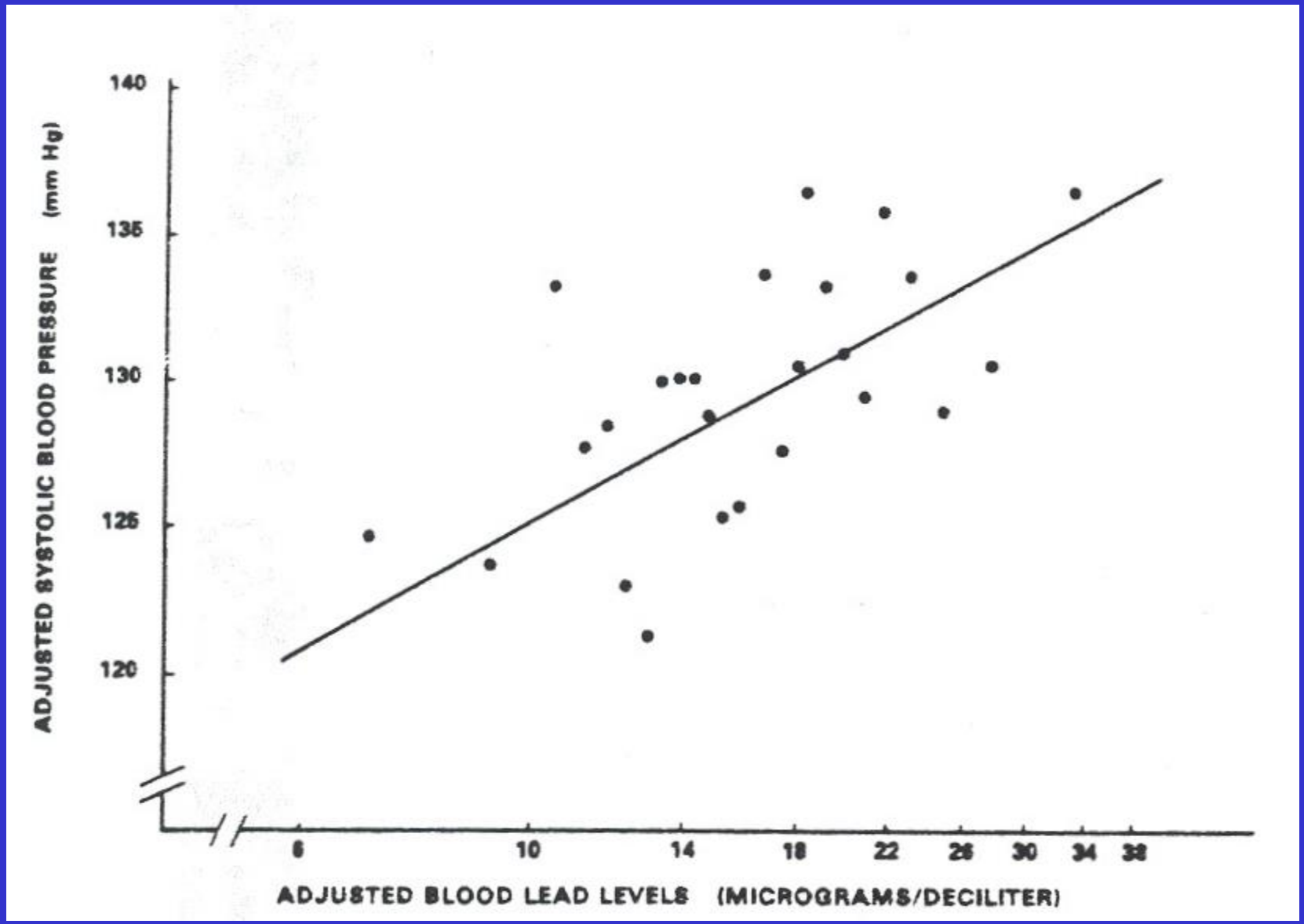

100
90
80
70
60
50
-40
-30
-20
-10
0
10
20
30
Calcaneus Lead Concentration


12
10
8
6
4
2
0
10.57
3.79
4.87
1.57
10.79
4.25
4.65
1.37
8.29
3.29
3.56
0.61
Present
Absent
< median (worse)
≥ median (better)
≥ median (worse)
< median (better)
MCI
DMS % correct (12 sec delay)
PAL Total Errors Adjusted
Calcaneal Lead (µg/g)
Tibial Lead (µg/g)

Change in MMSE Score by Patella Lead Level



Hypertension



Schwartz J. Environ Health Persp. 1991;91:71-73

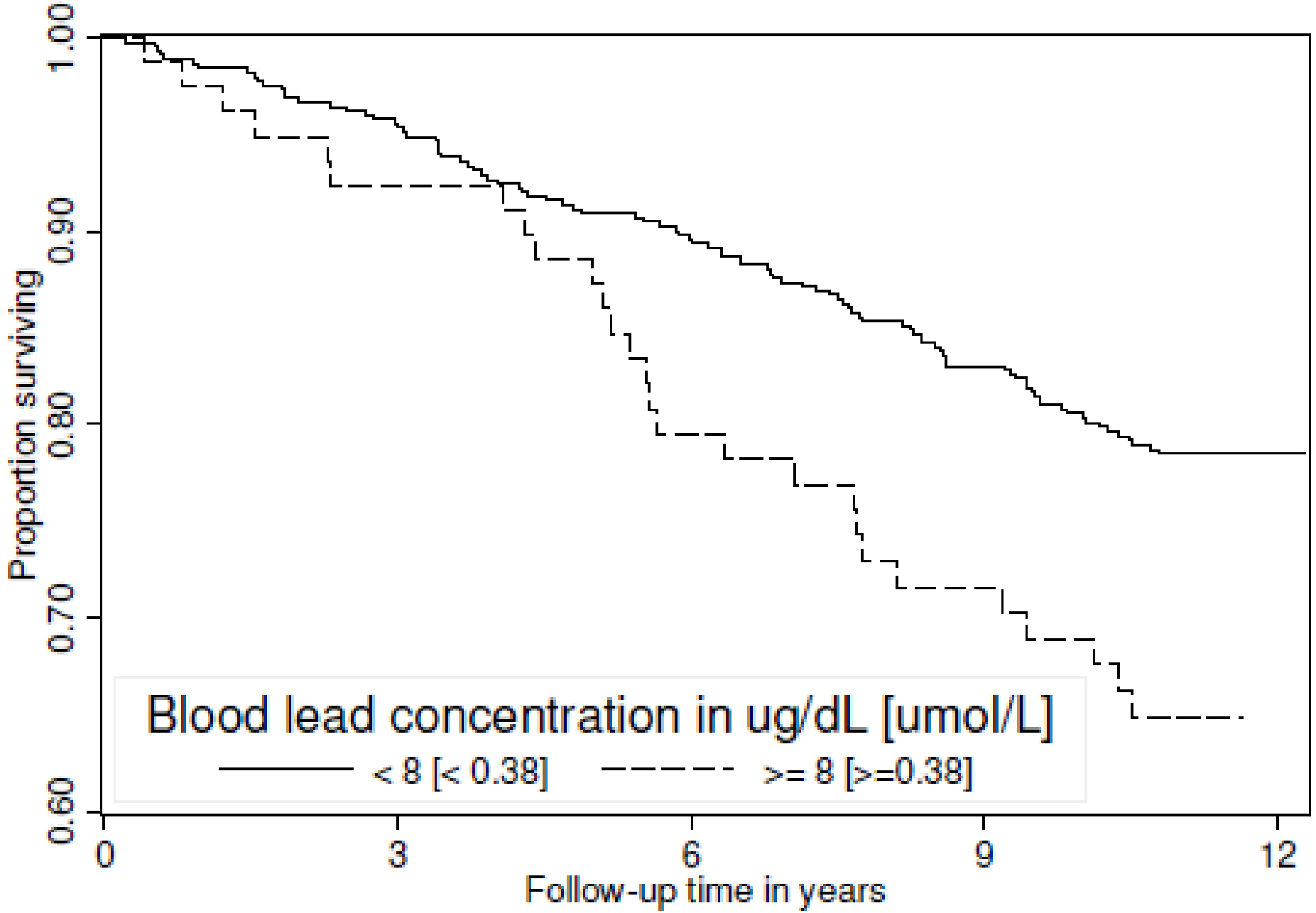
Risk of Hypertension by BLL

Postmenopausal Women Untreated for Hypertension				
No. in sample	163	148	166	156
Blood lead, mean (range), µg/dL	1.4 (0.5-2.0)	2.6 (2.1-3.0)	3.8 (3.1-4.6)	7.4 (4.7-31.1)
Systolic hypertension >140 mm Hg, OR (95% CI)‡	1.0	3.0 (1.3-6.9)	2.7 (1.2-6.2)	2.6 (0.89-7.5)
Diastolic hypertension >90 mm Hg, OR (95% CI)‡	1.0	4.6 (1.1-19.2)	5.9 (1.5-23.1)	8.1 (2.6-24.7)

Nash D. JAMA. 2003;289:1523-1532

Risk for All-cause, Cancer & CV Disease Mortality by BLL & Age

Cause of death/ blood lead level	No. of deaths	Relative risk (95% CI) by age category (years)			
		40–74	75–84	> 85	All
All causes					
< 5 µg/dL	1,402	1	1	1	1
5–9 µg/dL	828	1.30 (1.03–1.65)	1.38 (1.04–1.83)	0.98 (0.85–1.14)	1.24 (1.05–1.48)
≥ 10 µg/dL	255	1.73 (1.28–2.35)[b]	1.39 (0.93–2.08)[c]	1.67 (1.11–2.53)	1.59 (1.28–1.98)[b]
Cardiovascular disease					
< 5 µg/dL	684	1	1	1	1
5–9 µg/dL	394	1.11 (0.79–1.56)	1.41 (0.87–2.28)	1.07 (0.87–1.31)	1.20 (0.93–1.55)
≥ 10 µg/dL	111	1.47 (0.93–2.33)	1.71 (0.94–3.09)[c]	1.45 (0.85–2.48)	1.55 (1.16–2.07)[d]
Cancer					
< 5 µg/dL	282	1	1	1	1
5–9 µg/dL	194	1.44 (0.91–2.28)	1.46 (1.03–2.07)	1.44 (0.92–2.26)	1.44 (1.12–1.86)
≥ 10 µg/dL	67	2.27 (1.38–3.74)[d]	0.80 (0.38–1.69)	2.2 (1.13–4.29)[d]	1.69 (1.14–2.52)[d]


1.00
0.90
0.80
0.70
0.60
Proportion surviving
0
3
6
9
12
Follow-up time in years
Blood lead concentration in ug/dL [umol/L]
< 8 [< 0.38]
>= 8 [>=0.38]

Other Effects

Short stature

Decreased hearing

Anemia

Renal Disease

Dental Caries

Objectives

- Review the effects of lead exposure.
- **Review treatment strategies.**
- Review the current CDC guidelines.

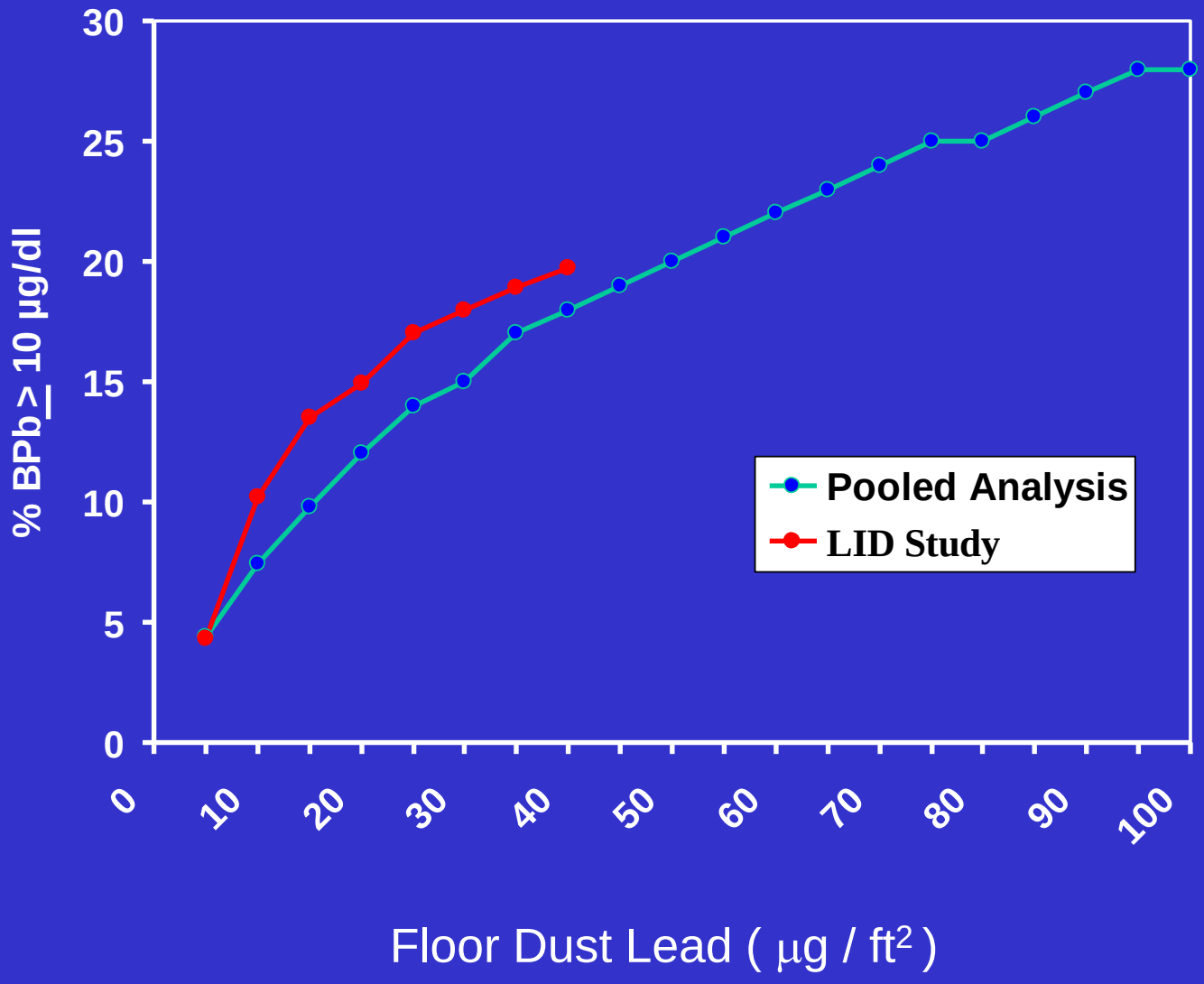
“ It has been assumed…children ingested lead…by picking at paint & eating chips…We hypothesize, rather, that lead is present in the *house dust*… Children’s hands are contaminated by contact with floors, and the dust is subsequently ingested by typical hand-to-mouth activity”

Sayre J. AJDC. 1974;127:167-70

Hand vs Blood Lead Level

	High BLL	Low BLL	P value
Mean hand Pb level (μg/towel)	30	12	0.01
Hand Pb level:			
≥ 20	31 (63%)	16	
< 20	18 (35%)	34	0.005

Charney E. Pediatrics 1980;65:226-31



Lanphear BP et.al. Env Research 1998;79:51-68

Efficacy of Dust Control

	Baseline	12 Month	Mean Change
Experimental Group (n=14)	38.6	31.7	- 6.9
Control Group (n=35)	38.5	37.8	- 0.7

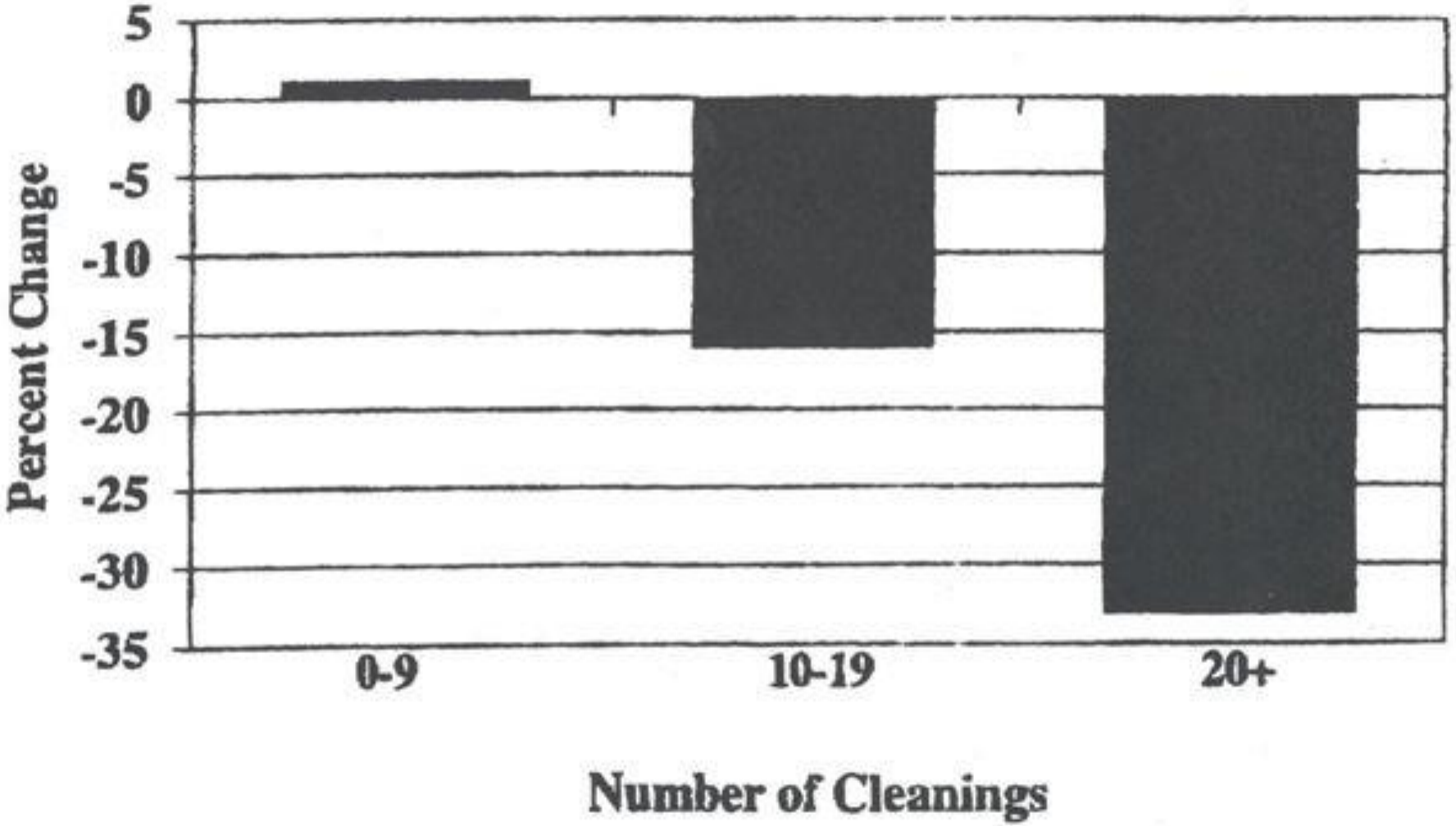
Charney E. NEJM 1983:309;1089-93

Efficacy of Dust Control

	Baseline	12 Month	Change
Experimental	12.4	10.3	-17%*
Control	11.6	11.6	0%

* $P < 0.05$

Rhoads GG. Pediatrics 1999;103:551-5


5
0
-5
-10
-15
-20
-25
-30
-35
Percent Change
0-9
10-19
20+
Number of Cleanings

Efficacy of Dust Control

Study	Outcome
Charney, 1983	18%↓
Rhoads, 1999	17%↓
Weitzmann, 1993	No effect
Aschengrau, 1998	No effect
Hilts, 1995	No effect

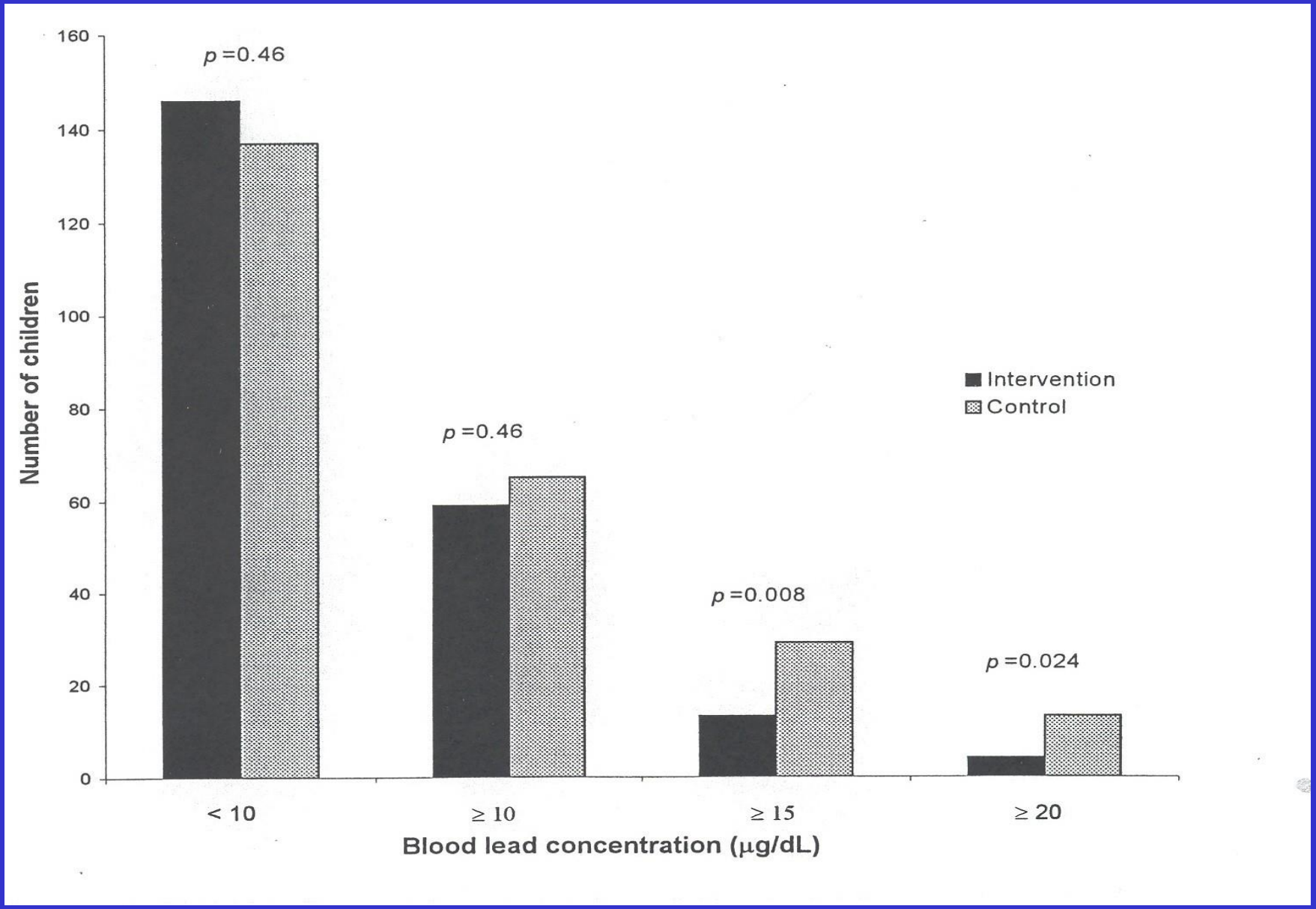
Efficacy of Dust Control

Study	Outcome	Cleaning Frequency
Charney, 1983	18%↓	Every 2 weeks
Rhoads, 1999	17%↓	Every 2-3 weeks
Weitzmann, 1993	No effect	Once
Aschengrau, 1998	No effect	Once
Hilts, 1995	No effect	Every 6 weeks

Effectiveness of Dust Control

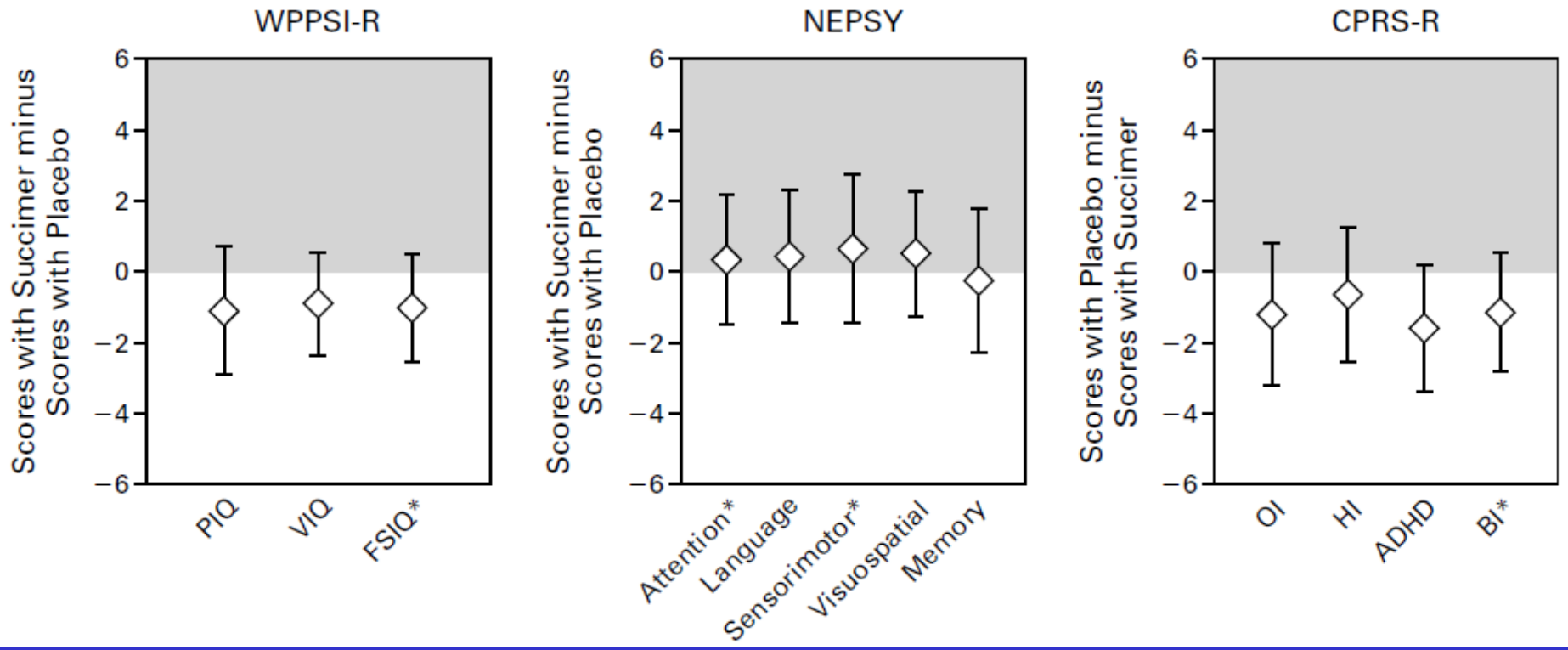
	Baseline		Follow-Up	
	Median	%>20	Median	%>20
Intervention	6.8	4%	6.2	2%
Control	6.1	5%	6.2	14%

Lanphear BP. Pediatrics 1996;98:35-40



Haynes EN. Environ Health Persp. 2003;110:103-7

Effects of Succimer or Neurocognitive Outcomes



Objectives

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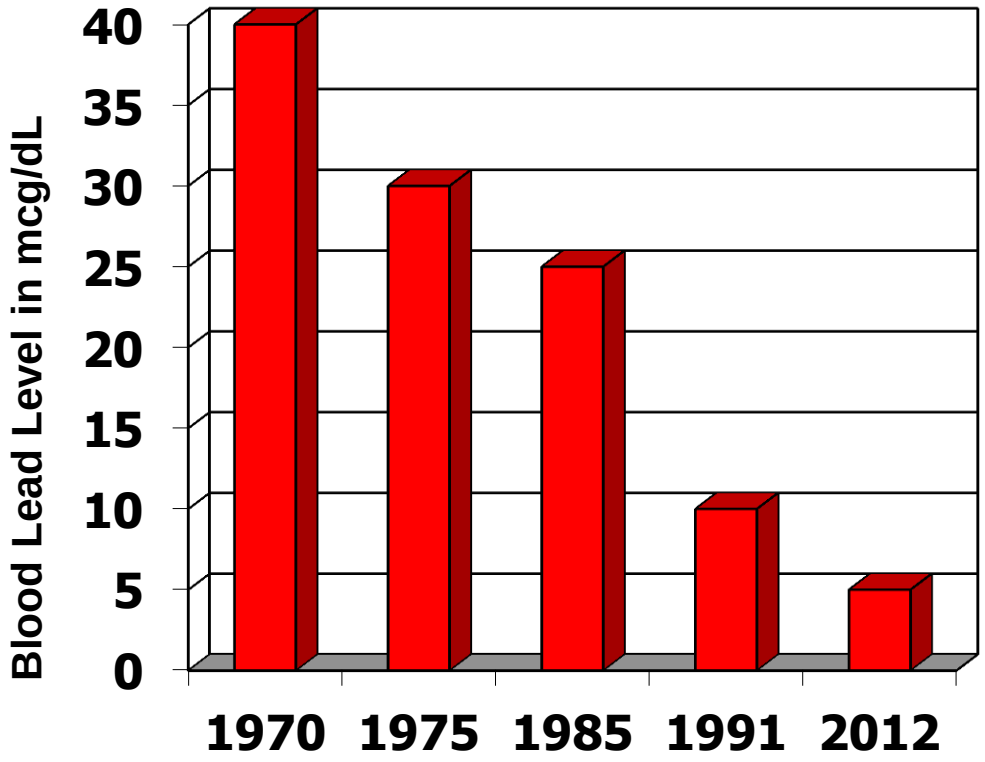
- **Review the current CDC guidelines.**

Blood Lead Cut-offs
As Determined by the CDC



National Trends in Blood Lead Levels

CDC replaces use of the term "Lead Level of Concern" with the new term "Reference Level" which is the cut-off below which 97.5% of children's lead levels fall.

	Percent of Children with Lead Levels:	
	≥ 5mcg/dL	≥ 10mcg/dL
1988-1991	**31.4%**	**8.6%**
1991-1994	**20.9%**	**4.4%**
1999-2004	**7.4%**	**1.4%**
2010	**2.5%**	**0.6%**

New Emphasis for Public Heath

- Since the effects are irreversible, the CDC underscored primary prevention.
- Education of medical providers so that they can educate families.
- Data sharing between health and housing authorities.
- Financing for lead hazard control.

The New Medical Guidelines

- The new reference level for blood lead was reduced from 10 μg/dL to 5 μg/dL.
- Initiate interventions at BLL ≥5 μg/dL.
- Close follow-up of children with blood lead levels ≥5 mcg/dL – every 3 mo.
- Educate families on lead sources and assess nutritional status.


Thank you for your attention!

Who to contact in Seneca County

Public Health - Childhood Lead Poisoning Prevention Program

(315) 539-1920

- lead testing
- case management for children found to have elevated blood lead levels
- educates family on hygiene, nutrition, and developmental concerns for children

Environmental Health - Residential Lead Paint Assessments

(315) 539-1945

- home inspections for levels at or above 15 µg/dL or if an MD requests
- educates on risk reduction measures and housekeeping interventions

www.co.seneca.ny.us

Outside of Seneca County

Public Health Departments

Ontario - (585) 396-4343 - www.co.ontario.ny.us

Wayne - (315) 946-5749 - www.co.wayne.ny.us

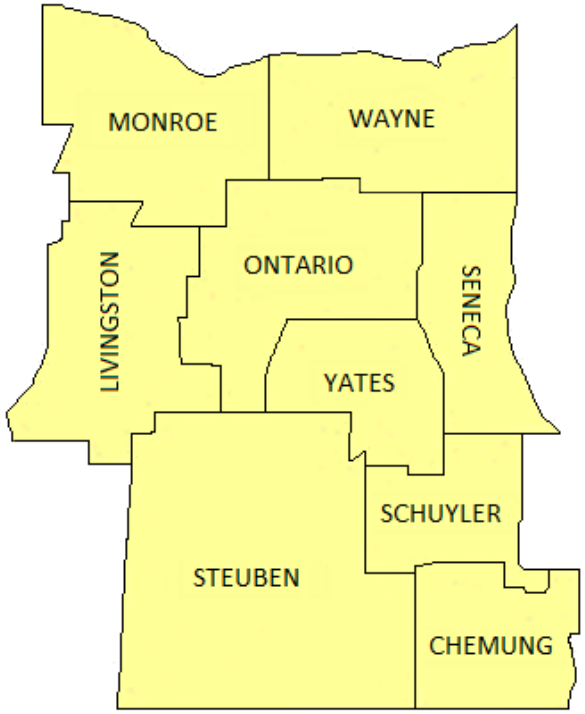
Yates - (315) 536-5160 - www.yatescounty.org

Environmental Services

Geneva District Office
(315) 789-3030

Western New York
Lead Poisoning Resource Center
Rochester Office

Serving nine counties in the Finger Lakes region:



Toll Free Number: 877-352-5775

Web: Golisano.urmc.edu/lead-poisoning

Stanley Schaffer, MD, MS
Medical Director

James Campbell, MD, MPH
Co-Medical Director

Jennifer Becker, MPH
Project Coordinator

* Support to medical providers and local health departments within the region. Our center works to improve lead testing and provide education and prevention activities;
* Consultation with medical providers on the medical management of children and pregnant women with lead poisoning;
* Consultation with local health department staff on case coordination of children and pregnant women with lead poisoning;
* Provision of lead poisoning prevention information and materials to providers and the public.

"(Primary prevention)… is the only "treatment" that is likely to be successful. Today, a team approach is required, involving the physician, public health nurse, social service worker and environmental inspector"

Chisholm JJ. Pediatrics. 2001;107:581-583