

J 5987

OF
EVALUATION OF LONG-TERM EFFECTS/ELEVATED BLOOD LEAD CONCENTRATIONS
IN ASYMPTOMATIC CHILDREN

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The purpose of this paper is to contribute objective data toward the often expressed hypothesis that subclinical elevation of body lead burden may have permanent deleterious effects on the physical and mental development of children.

A unique group of children discovered accidentally presented a naturally occurring experimental model for the study.

This group of experimental children with good nutrition, no anemia, and happy homes in a three generation small community, leave elevated blood lead as an apparent isolated significant variable.

The children were matched with a control group, tested on a blind basis and the results analyzed for any significant differences.

Results of the study are presented as objective evidence to aid in determining safe levels of lead exposure. Initial evaluation of this group of children suggest that prolonged exposure to subclinical lead levels in the 40-80 mcg% range has not resulted in apparent deleterious effects.

N 27641

This study supported by grant LH-208 from International Lead and Zinc Research Organization.

1. Introduction.

In January 1972, a unique situation was discovered in El Paso, Texas, which represented an opportunity to test the hypothesis that subclinical elevations of body lead burden in the 40-80 mcg% range may have a permanent deleterious effect in children [1] [2] [3] [4] .

Smeltertown, adjacent to a large smelter in operation for eight years was found to be highly contaminated with lead. Blood lead screening test indicated 67% of the 206 children residing there had lead values over 40 mcg%. El Paso incidence excluding Smeltertown (Old Fort Bliss, not included in the study) was estimated at 2% (Table 1).

2. Clinical Model for Study.

2.1 Test Group.

One hundred thirty eight of the 206 children agreed to participate in this study. Sex distribution was 68 male and 70 female. Age distribution was evenly distributed from 21 months to 18 years with a median of 9 years (Table 2).

Availability of high lead content paint was low and similar between Smeltertown and El Paso. The sources of lead were presumed to be ambient air and contaminated soil from the smelter [5]. Environmental conditions, consistent plant operations, serial blood lead determinations for two years and age distribution suggest that the Smeltertown children have had sustained asymptomatic elevations in body lead burden.

2.2 Controls.

Control groups were chosen from children residing outside of Smeltertown and were matched with those in Smeltertown by age, sex, race, and family income. A second control group of pre-school age children was obtained from a rural community approximately 12 miles from the smelter.

2.3 Matching.

Spanish is the principal language for all groups. More specific control matching data for the lead test group, city group, and rural control group is tabulated in Table 3. The difference in income was probably related to the higher union wage paid by the smelter. Despite similar education and job rating, 19 of these 22 fathers were in the upper 2 income groups.

3. Procedure.

All children were evaluated on a blind basis by examiners who were given only a study number, first name, and age for each child. Evaluation

included a subjective history questionnaire obtained from the parents, a physical and neurological examination, nerve conduction test, blood lead, hemoglobin, hematocrit, SMA-14, erythrocyte protoporphyrin, and urinalysis. X-rays of the hands and wrist were made for gross evaluation and computer analysis for bone weight, density, and size. The psychometric evaluation, using tests depending on age, included: WISC, WAIS, McCarthy Scales, Peabody, Draw-A-Person, WRAT, Oseretsky, Wepman Auditory Discrimination, Berry Visual Motor Integration, Frostig, and California Test of Personality.

4. Analysis.

The experimental children and matched controls were grouped for analysis by blood lead levels. Other parameters of lead exposure, erythrocyte protoporphyrin levels, living in area during critical period of birth to three years of age, total time in area more than two years, and positive X-ray findings were used in combination to seek out the high risk children. Those children with 4 of these 5 parameters positive were placed in a serious group, and those with 3 of 5 positive parameters were added to the serious group to form a moderate group for analysis.

Results were tabulated and preliminary statistical analysis were run using F Test of Equality of two variances ($F=S^2_1/S^2_2$) and T Test. A probability level of 0.05 (5%) was used to compare groups for significant differences. Data is being analyzed for significant variables before more sophisticated statistical analysis is conducted.

5. Results.

There are significant expected differences in time in area, blood lead values, and protoporphyrin levels to clearly separate the lead children from the controls (Table 4).

Pica was significantly higher in the lead group. This included ingestion of dirt and may represent increased awareness in reporting from the lead group parents.

Fourteen non-specific complaints frequently mentioned as symptoms of plumbism were infrequent and similar between test and control groups and were essentially noncontributory.

Health history was good and similar between groups.

General physical and neurological exam was normal. Finger to thumb opposition and alternating hand movements showed expected variances with age but no difference with controls[6]. Nerve conduction tests were normal.

Hemoglobin and hematocrit values were normal. Group mean average hemoglobin ranged from 14.3 grams in lead children less than eight years of age to 16.8 grams in total controls--adjusted for age to percentage of normal, the range was 98.1% to 102.2%. Eight of nine lead groups were a shade lower but none were significantly different.

SMA-14 values show some minor differences statistically, but all values are within normal range.

Hyperactivity was not demonstrated[7]. Test values are actually a shade in favor of lead children but differences were not statistically significant (Table 5).

Psychometric values are similar to those found in routine testing in El Paso Schools. The Peabody test slightly favors the controls and Draw-A-Person test favors the lead group, neither difference is significant.

The WISC gave a verbal IQ of 86.86 for lead against 86.94 for the control group, performance IQ of 95.19 for lead against 93.06, and a total IQ of 90.95 for lead against 88.89 for control group. These and all subgroups show no significant differences.

The McCarthy Scales for 29 children under 6 years of age gave a general cognitive scaled score of 83.24 for lead against 84.43 for the control group and was not significant.

No significant differences occurred in the total group comparisons of the WRAT, Wepman, Bender, and Oseretsky tests (Table 6).

The most significant difference is in the California Test of Personality. This shows in the total group but almost disappears in the moderate group. Group less than forty shows more significant differences than group greater than sixty. This difference is more logically explained by geographic isolation, closing of Smeltertown School, news media exposure because of lead problem, and forced displacement from homesteads.

6. Conclusions.

Any source of lead causing undue absorption in humans must be controlled. From a practical standpoint, the practicing physician, concerned government agencies, and industry must know what is safe.

Data from this study is still being analyzed for other possible subtle changes or trends, but initial results support the current United States Surgeon General Guidelines for Safety[8].

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Table I.
LEAD SCREENING RESULTS

Number of Children	Total	Blood Lead		% > 40 mcg
		< 40 mcg%	> 40 mcg%	
SMELTERTOWN				
Study Group	138	37	101	73%
Non-Study Group (13--no lead value)	68	27	28	51%
EL PASO				
Initial City Tests	75	75	0	} 2%
CDC and BCCM Pilot Screen	550	538	12	
Mesita School Children	69	69	0	
ILZRO Study Controls	142	140	2	

Table II.

AGE DISTRIBUTION IN LEAD CHILDREN

NUMBER OF CHILDREN																			
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14					
	*	*	*	*	*	*	*	*	*	*	*	*	*	*					
		*	*	*	*	*	*	*	*	*	*	*	*	*					
			*	*	*	*	*	*	*	*	*	*	*	*					
				*	*	*	*	*	*	*	*	*	*	*					
					*	*	*	*	*	*	*	*	*	*					
						*	*	*	*	*	*	*	*	*					
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Table III.

CONTROL MATCHING DATA			
	Lead	City Control	Rural
Average Age Difference	- .69 day	+ .69 day	
Lead Under 8 Years	+4.64 day	----	-4.64
RACE			
% Mexican/American			
Father	94%	96%	95%
Mother	97%	99%	93%
Child	96%	97%	96%
JOB LEVEL			
Father	1.53	1.43	1.70
Mother	1.06	1.10	1.07
EDUCATION			
Father	7.54 years	7.83 years	8.45 years
Mother	7.27 years	6.77 years	7.65 years
INCOME (Annual)			
Group Average	2.27	1.92	2.42
Dollar Approx. of Annual Income	4,540	3,840	4,840

Table IV.

EXPECTED SIGNIFICANT DIFFERENCES

Time in Area	Lead		Control		Rural	
	#	Years	#	Years	#	Years
Father	112	22	7	7 1/2	2	9 1/2
Mother	135	23	8	8	0	0
Child	138	7	0	0	0	0
Blood Lead						
Total	M-50	(14-93)	M-20	(7-43)	M-16	(10-28)
Moderate	M-61	(14-93)	M-22	(8-40)		
8 years	M-56	(15-93)	M-23	(10-43)	M-16	(10-28)
Protoporphyrin						
Total	M-186	(20-710)	M-80	(26-303)	M-67	(21-167)
Moderate	M-239	(68-710)	M-84	(26-303)		
8 years	M-195	(39-550)	M-91	(26-303)	M-67	(21-167)

Table V.

HYPERACTIVITY EVALUATION

Groups	Total Pb.	Con.	Mod.Pb.	Con.	Pb<8yrs.	Rural Con.	City Con.
Estimate with Physical	6.10	6.51	6.05	6.37	6.10	1.75	7.25
Test with Physical	5.43	5.60	5.45	5.61	5.75	6.04	6.45
Parent Questionnaire	15.4	16.7	15.9	17.2	17.2	23.2	19.7
Teacher Questionnaire	5.03	5.17	5.59	6.40	6.51	6.52	7.31

Table VI.
COMPARISON OF I.Q. TESTS

Pb. : Con. No. F T					Mod. : Con. No. F T					Pb<8 : Con. No. F T					Rural City : No. F T				
Verbal I.Q.																			
86.9 86.9 99 1.15 0.04					87.0 88.1 52 1.09 0.50					93.6 89.4 18 1.55 0.93					89.4 92.3 17 2.66 0.66				
Performance																			
95.2 88.9 99 1.30 1.26					94.9 95.8 52 1.02 0.37					100.6 97.5 18 1.55 0.83					97.5 95.3 17 1.23 0.55				
Full Scale																			
90.1 88.9 99 1.04 0.73					90.0 91.0 52 1.16 0.39					96.7 92.5 18 1.59 1.01					92.5 93.1 17 3.26 0.14				
WISC																			
Verbal																			
41.6 42.1 29 1.21 0.20					39.5 40.5 20 1.26 0.36					42.0 39.4 22 1.14 0.90					39.4 40.7 23 1.14 0.49				
Perceptual																			
42.1 41.0 29 1.78 0.52					41.8 41.1 20 1.79 0.22					42.3 39.6 22 2.19 1.04					39.6 39.3 23 1.01 0.11				
Quantitative																			
39.5 42.0 29 1.22 0.99					39.4 39.1 20 1.17 0.10					39.6 39.0 22 1.47 0.21					39.0 41.2 23 1.72 0.76				
General Cognitive																			
83.2 84.4 29 1.09 0.32					80.9 82.0 20 1.22 0.26					83.8 80.2 22 1.01 0.81					80.2 81.9 23 1.13 0.39				
Peabody																			
83.8 86.9 115 1.07 1.44					83.1 85.9 60 1.07 0.86					83.0 84.6 27 1.22 0.32					84.6 84.0 17 1.39 0.12				
Draw-A-Person																			
87.5 87.3 109 1.16 0.07					91.4 89.4 58 1.16 0.65					95.4 91.3 23 1.72 0.73					91.3 90.6 17 1.39 0.12				
Reading Standard Score																			
88.7 90.0 111 1.60 0.65					89.9 87.6 57 1.85 0.98					89.3 89.2 23 1.72 0.05					89.2 87.7 17 1.02 0.49				
Arithmetic Standard Score																			
86.1 86.6 111 1.16 0.26					88.7 87.6 57 1.18 0.50					88.3 90.0 23 1.33 0.34					90.0 90.0 17 1.16 0.01				
Spelling Standard Score																			
87.3 87.0 111 1.16 0.16					89.4 85.7 57 1.14 1.69					95.0 91.6 23 1.14 0.98					91.6 89.6 17 1.55 0.49				
TOTAL LEAD GROUP					MODERATE LEAD GROUP					LEAD< 8 YR. & RURAL					RURAL & CITY CONTROL				