LIA14326

From the Director of Health and Safety
Lead Industries Association, Inc.
292 Madison Avenue
New York, N. Y. 10017

Members 50

Look Ahead with Lead

December 14, 1967

LEAD HYGIENE AND SAFETY BULLETIN
No. 175

To: All Members of the Lead Industries Association, Inc.

Re: Paper by Dr. Goldwater giving results of WHO study on Lead in 15 Countries

Attached for you is a copy of the paper given in San Francisco at the American Public Health Association 1966 Annual Meeting. You will remember some press coverage of this paper which specifically mentioned the New Guinea native blood lead results which showed that primitive peoples with no industrial lead exposure were normal as to body lead content as compared to people from fifteen industrialized countries.

In our opinion, this is one of the most important documents ever to appear as far as its factual analysis of the situation is concerned, and we suggest the widest possible distribution to individuals who have an interest in air pollution. For this reason we have obtained extra copies and hope that you will request them for those representatives of government and other agencies in your areas who have addressed themselves to the question of air pollution and who are likely to show interest. Such individuals would include your state and local legislative representatives.

Since most of the press and public reaction to lead and the question of air pollution has been unfavorable, we urge that you make wide use of this study by the World Health Organization. As you will note, the study was sponsored by the WHO with the support of the United States Public Health Service, so that it has been issued under the highest auspices of government.

We hope that we will be favored with a large number of requests from you for extra copies of the paper.

Very truly yours,

Don G. Fowler

DGF:sw
enclosure

N 3510

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An International Study of "Normal" Levels of Lead in Blood and Urine

Leonard J. Goldwater, M.D., and A. Walter Hoover, M.D., New York

In 1960, the World Health Organization and the Columbia University School of Public Health and Administrative Medicine became interested in the status and validity of current concepts of "normal values" of lead in the blood and urine. For the purpose of this study the term "normal" means the amount found in persons who have had no evident occupational, medicinal, or other unusual sources of exposure.

Preliminary investigation was carried out by means of a questionnaire sent to a number of established foreign investigators requesting the values for lead in the blood and urine accepted by each investigator as being within the normal range. The information gained in this manner revealed a wide range of values based mostly on the experience of each investigator in personal studies of unexposed groups. Review of the post World War II literature showed considerable differences in values between countries and even within the same country. All of these data immediately posed the question: Are the differences in means and ranges real or are they due to differences in laboratory techniques or to other variables?

In order to eliminate variance of laboratory technique or method as a significant factor, it was decided to design a study in which specimens from all sources were sent to a single central laboratory for analysis by a single standard method. Collaborating laboratories were selected in 15 countries and in three sections of the United States. The study was begun in 1961 with the cooperation of WHO and the support of the Division of Occupational Health of the US Public Health Service.

Submitted for publication Dec 2, 1966, accepted Feb 22, 1967.

From the Division of Occupational Medicine, School of Public Health and Administrative Medicine, Columbia University, New York.

Read before the Session on Evaluating the Health Effects of Air Pollution during the annual meeting of the American Public Health Association, San Francisco, Nov 1, 1966.

Reprint requests to 600 W 168th St, New York 10032 (Dr Goldwater).

Method

All collaborating laboratories made their own arrangements for obtaining samples. Many subjects were hospital employees or clinic patients because of easy availability but they were screened for unusual exposure to lead. Blood and urine specimens were obtained from "normal" subjects of both sexes in rural and urban areas. Specimens of 120 cc urine (taken from pooled 24-hour specimens) and 25 cc of blood were obtained from each of no more than 20 subjects per year in each collaborating laboratory area. The specimens were placed in chemically clean glass containers or polyethylene bottles and shipped by air mail or air express to Columbia University, Division of Occupational Medicine. All specimens were analyzed by a standard dithizone method under the supervision of the late Morris B. Jacobs, PhD.

Results

Table 1 shows results by country for urine and blood lead with range, mean, median and standard deviation (SD).

Tables 2 and 3 list comparisons between urine from urban and rural subjects and blood lead levels with median, mean, and SD.

On the basis of the findings of the present study as well as of other studies it can be suggested that the "normal" levels of lead in

Table 1.—*Urine Lead and Blood Lead Values by Country*

Country	μg/Liter of Urine					μg/100 ml Blood				
	Sample Size	Range	Median	Mean	SD*	Sample Size	Range	Median	Mean	SD
Argentina	46	10-75	28	31	13	49	8-50	14	14	5
Chile	35	8-75	36	36	15	35	8-50	19	17	6
Czechoslovakia	29	8-70	49	43	20	20	0-50	19	20	8
Egypt	27	10-96	42	40	19	26	8-50	17	20	13
Finland	46	10-96	46	46	15	45	10-60	25	26	12
Israel	81	1-75	26	27	12	67	8-40	12	15	5
Italy	29	10-50	26	31	10	26	8-40	10	13	10
Japan	40	8-90	32	30	19	40	8-60	20	20	8
Holland	60	10-76	36	33	14	60	0-45	13	15	7
Peru	33	8-50	21	22	9	32	0-35	6	7	5
Poland	98	8-96	25	27	13	76	0-35	12	12	6
Sweden	30	8-46	23	24	9	30	8-25	10	10	3
Yugoslavia	76	8-80	28	28	10	66	8-80	20	24	16
United Kingdom	30	0-86	44	41	25	30	0-45	21	23	13
United States										
California	27	15-75	39	38	15	33	10-37	17	17	17
New York City	110	8-116	33	38	25	106	0-100	17	21	15
Ohio	40	10-80	30	31	12	40	10-53	17	16	8
New Guinea	...	...	...	...	...	38	10-60	21	22	5
Total	829					801				
Aggregate			33	35	14			18	17	11

* Standard deviation.

the urine range from 20 μg/liter (approximately 28% of the samples were at this level or less) to 65 μg/liter, with the average around 35 μg. The present study reveals that 95% of the grand total of the populations examined had less than 65 μg of lead per liter of urine.

The "normal" values of lead in the blood range from 15 μg to 40 μg/100 ml. Of the total population, more than 98% had lead values less than 50 μg/100 ml of blood. In general, blood lead levels of urban subjects were found to be slightly higher than those from rural subjects. There was no significant difference between the sexes.

Comment

In a recent comprehensive review, Stoppe has tabulated all available data on "normal" blood and urine lead levels from 1925 to 1965.[1] While his findings show a certain amount of variation among the numerous studies, the ranges and means are not greatly different from those of the present investigation. Of particular interest is the fact that there is no significant change in the "normal" blood and urinary lead over the past three or four decades.

It is a well-known fact that a certain amount of lead enters the human body daily, mainly by ingestion and inhalation. Most of this amount is excreted in the feces without being absorbed into the blood stream.[2] Ingestion of lead compounds in food and drinking water and other beverages contributes most of the daily lead intake. The air also contributes to intake (by inhalation), although to a considerably lesser degree than ingestion. The levels of lead in the blood and urine are generally believed to reflect the degree of exposure and absorption.

Concern has been expressed that increased burning of gasoline by the internal combustion engine and the wider use of lead in industry are causing additional exposures to lead in our environment. At the same

Table 3.—Lead Concentrations in Urine by Residence (μg/Liter)

	Urban					Rural				
Country	Sample Size	Range	Median	Mean	SD	Sample Size	Range	Median	Mean	SD
Argentina	42	10-75	27	32	15	6	20-35	25	27	7
Chile	34	5-75	26	27	15	1	50	...	50	...
Czechoslovakia	20	5-70	40	43	20	...	...	...	...	...
Egypt	18	10-95	46	46	21	9	10-65	22	27	16
England	30	0-95	44	41	26	...	...	...	...	...
Finland	17	35-95	48	50	15	29	10-68	46	43	15
Holland	58	10-75	30	33	15	2	15-30	22	22	11
Israel	51	5-70	39	41	13	22	5-70	30	34	12
Italy	29	10-50	26	31	10	...	...	...	...	...
Japan	32	5-90	29	40	17	8	20-60	36	38	13
Peru	32	10-50	21	22	9	...	...	...	...	...
Poland	32	10-50	28	29	12	44	5-95	25	26	15
Sweden	14	10-45	26	28	10	16	5-30	22	21	8
Yugoslavia	30	15-45	28	29	10	16	20-60	50	47	12
United States										
California	23	15-75	40	44	17	6	15-45	25	28	13
New York City	110	5-120	23	30	25	...	...	...	...	...
Ohio	20	15-75	42	45	19	20	15-30	16	17	4
New Guinea	...	...	...	...	...	...	...	...	...	...
Total	562					177				

Table 2.—Lead Concentrations in Blood by Residence (μg/100 ml)

	Urban					Rural				
Country	Sample Size	Range	Median	Mean	SD	Sample Size	Range	Median	Mean	SD
Argentina	43	5-50	14	16	10	6	5-15	11	9	5
Chile	34	5-30	19	18	6	1	15	...	15	...
Czechoslovakia	20	0-50	19	20	8	...	...	...	...	...
Egypt	19	10-50	15	23	16	9	0-30	11	12	9
England	30	0-45	21	23	13	...	...	...	...	...
Finland	17	10-50	29	28	10	29	10-60	21	24	14
Holland	58	0-45	12	15	9	2	10	10	10	0
Israel	46	5-40	15	16	6	13	10-25	18	18	5
Italy	26	5-40	18	13	10	...	...	...	...	...
Japan	32	5-60	21	21	11	8	10-30	19	18	7
Peru	32	0-25	6	7	8	...	...	...	...	...
Poland	32	5-25	12	12	6	44	5-35	12	13	7
Sweden	14	5-15	9	9	3	16	5-15	10	10	3
Yugoslavia	30	5-30	15	15	6	16	5-60	29	32	16
United States										
California	27	10-25	19	19	4	6	10-30	18	17	6
New York City	106	0-100	17	17	15	...	...	...	...	...
Ohio	20	10-50	18	18	10	20	10-25	11	12	6
New Guinea	...	...	...	...	...	36	10-40	21	22	5
Total	585					208				

tions the amounts of environmental lead from insecticides, lead pipe, and paints have decreased. It would appear that the increase of lead from the former sources has been balanced by decreases from the latter.

The lead levels reported in the blood of the New Guinea aborigines (Table 2) are of particular interest in that these natives, living in the hills of New Guinea, away from industrialization and motorization, showed blood lead levels higher in range than urban and rural Californians. The mean figure of 22-μg/100 ml of blood was higher than that of samples from 13 other localities, including California, Ohio, and New York city. Mean levels from England, Yugoslavia, and Finland are slightly higher than the New Guinea mean.

Because of these findings, more detailed information was obtained from the medical officer serving this New Guinea area. The general environment is completely nonindustrial and is free of even minimal amounts of gasoline fumes. Cooking is done in utensils made of unfinished bamboo tubes. Other domestic utensils are made mostly of wood. These observations serve to illustrate the difficulties in assuming a simple relationship between residence and body lead levels. Variations in the lead content of "virgin" soils has been pointed out by Kehoe.[2]

Summary and Conclusions

The results of a study of "normal" lead levels in the blood and urine of inhabitants of 15 foreign countries and the United States have been reported. A total of 829 urine specimens and 801 blood specimens have been analyzed for lead content in a central laboratory using a standard dithizone method.

The "normal" level of lead in the urine may be assumed to center about a mean of 35-μg of lead per liter of urine. Levels of less than 65-μg of lead per liter of urine were found in 95% of the samples tested.

A "normal" range of lead in the blood is suggested from 15-μg to 40-μg of lead per 100 ml of blood. In 95% of the tested population, values below 50-μg/100 ml of blood were found. The mean value of the present study was 17-μg of lead per 100 ml of blood with a standard deviation of 11.

New Guinea aborigines show average lead levels in blood comparable with those of industrialized countries.

Recent investigations of the lead content of human blood (including the study reported here) do not differ greatly from those shown by older investigations during the past three decades.

Samples of urine and blood used as a basis for "normal" values were provided by Juan Kaplan, MD, Argentina; Ricardo Haddad, Chile; Jaroslav Teisinger, MD, Czechoslovakia; Mostafa El Batawi, MD, Egypt (United Arab Republic); E. King, England; Leo Nora, MD, Finland; M. Wasserman, MD, Israel; Enrico C. Viglani, MD, Italy; Seiva Yamaguchi, MD, Japan; George C. E. Burger, MD, The Netherlands; Kazimierz Sperl, MD, and Henryk Urbanowicz, MD, Poland; Lars Friberg, MD, Sweden; F. Valic, PhD, Yugoslavia; Irving B. Tabershaw, MD, University of California; and B. D. Dinman, MD, Ohio State University.

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References

1. Shapiro, G.J.: Lead Concentration in Blood and Urine of "Normal" Populations: A Review, read before the Symposium on Environmental Lead Contamination, Washington, DC, Dec 13, 1966 (mimeographed).

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