STUDY OF AIR AND POPULATION LEAD LEVELS IN JAPAN

K. TSUCHIYA

School of Medicine, Keio University, Tokyo, Japan

A report claming that an outbreak of lead poisoning had occurred among inhabitants of an area in Tokyo with heavy vehicular traffic aroused immense public concern. In order to provide evidence that there is no reason for such concern an extensive study into the relationship between lead in air and its biological effects on Tokyo inhabitants has been carried out. The paper also reports on other less extensive studies in Japan on the same topic. These studies carried out on 3500 Tokyo inhabitants, on 100 inhabitants of the Fukuoka city and on 56 residents of Okinawa gave results similar to the major study.

About 2300 policemen were examined for hematocrit, red corpuscle count, hemoglobin, blood lead level, urine lead level and delta-aminolevulinic acid (ALA) in urine, and interviewed about smoking, drinking and drug practices. The concentration of lead in air was monitored at ten sampling stations in Tokyo and one on an offshore Japanese island in the Pacific.

The overall mean atmospheric lead concentration was 0.65 $\mu g/m^3$. The means of blood lead levels were from 16.8—18.7 μg/100 ml depending on the areas of employment and residence. The mean lead levels in urine were 7.8—12.2 μg/l.

Except for the pollution originating from a fixed source of lead there is no evidence in Japan that lead in the atmosphere would affect biological responses in human, particularly blood lead levels.

In 1970 a newspaper quoted a report by a general practitioner in Tokyo which claimed that an outbreak of lead poisoning had occurred among inhabitants of a heavily congested area in Tokyo. According to the report the highest blood lead level in this area was 130 μg/100 g.

Although the report was subsequently refuted by a competent laboratory, a number of Japanese, believing to suffer from lead poisoning, visited local health departments. As a result, approximately 3,500 people were biologically tested in Tokyo for possible poisoning by ambient lead. More recently, *Kodama* and coworkers (1) reported the results of their study on inhabitants of Kyushu Island and Okinawa. The number of subjects in this study was rather small. A 1972 report by *Okutani* and *Harada* (2) refers to an episode of possible health effects by lead which was being emitted from the smoke stacks of an iron works.

None of these reports, however, explored the possible effects of chronic exposure to low lead levels in heavily congested areas by measuring biological responses in apparently healthy individuals who live or work in a large urban community and its suburbs. Consequently, *Tsuchiya* and coworkers (3) undertook such a study in 1971, the results of which were published elsewhere (4). The present paper will deal primarily with the latter study, but will also give a brief overview of the three studies mentioned previously.

Prior to the study carried out by our group, general population was considered suitable for such an investigation. Later it proved unsatisfactory because many who were selected as subjects refused to participate. Only those who believed that lead in the air actually had deleterious health effects would consent to investigation. As a result, we selected policemen as subjects of the study, since this virtually guaranteed full cooperation on the part of the participants. The specific objectives of the study were:

a) to determine the lead concentration levels in the ambient atmosphere of the Tokyo Metropolitan Area (TMA) and to measure their differences according to geographical area, season and other factors.

b) to measure the levels of lead and other relevant physiobiochemical responses in the blood and urine of apparently healthy persons in TMA.

c) to examine whether or not these measurements have any relationship to exposure to lead at various levels in the atmosphere of their residences, working places and working conditions.

d) to investigate the relationships between the biological measurements, on one hand; and food, smoking habit and age on the other, in the study of population.

e) to determine the interrelationships among the measurements of apparently healthy persons living in one of the largest urban communities in the world.

MATERIALS AND METHODS

Since this study has two distinct aspects (aerometric and biological) each will be described separately.

Aerometric studies

For the sake of convenience, it was decided to establish ten air sampling stations in various parts of the Tokyo Metropolitan Area. Utilizing selected police stations as the actual sampling sites was advantageous for many reasons. For example, about 88 police stations are widely distributed over the Tokyo Metropolitan Area; thus, it was possible to select police stations to coincide exactly with the study design. Another advantage was that complete cooperation was promised by police authorities at the onset of the study. An outer island police station was also selected as representative of an area without air pollutants. This station, Hachijo Island Police Station, is situated on an island approximately 300 kilometers south of Tokyo. Figure 1 shows the locations of the eleven sampling stations, with overall means of atmospheric lead ($\mu g/m^3$) in brackets.

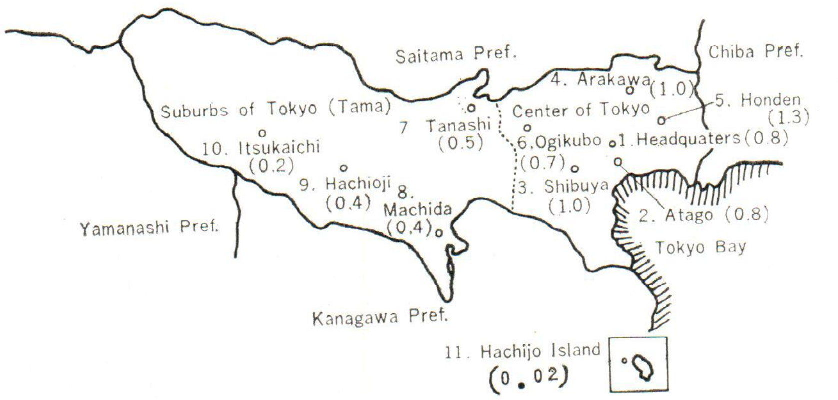

Fig. 1. *Locations of air sampling sites and overall mean concentrations of lead in air ($\mu g/m^3$): Average Pb concentration in the air*

Air sampling was accomplished with a high-volume sampler, continuously for 24 hours during three days per work week. High-volume samplers were installed on the roof of each of the eleven police stations. The station buildings were all two-story, with the exception of the headquarters which was a six-story building. All samplers were in operation over a thirteen month period from September 1971 through September 1972.

After the air was sampled, all filter papers were weighed after drying for two hours in an oven at 120 °C. A portion of the filter paper was punched to obtain several discs measuring 2 × 2 cm. These discs were immersed in 1 N HNO_3 and heated at 100 °C for 30 minutes. Finally the solution was analysed by the polarographic method.

Biological studies

The subjects for the biological studies were selected from police officers engaged in patrol, traffic control, and traffic desk duties. All the Hachijo Island Station Police participated, since althogether there were only 24 policemen.

Table 1

Number of traffic and patrol policemen in Tokyo and those sampled in the study

Duty	No. of policemen	Allocated size of sample	Actual No. sampled
Patrol duty	11,304	1,500	1,908
Traffice control duty	3,590	1,000	—
Desk duty	876	500	351
Hachijo I.	24	24	24
Total	15,794	3,024	2,283

Table 1 shows the sampling scheme of about 3,000 policemen selected from a total of 15,794 police officers. The purpose and significance of the study were explained to those who were chosen as subjects. All had to fill in a questionnaire and were interviewed about age, place of work and residence, type of duty, number of years living in the place of residence, number of years of smoking, number of cigarettes smoked per day, number of years of smoking before quitting, number of years of smoking since quitting, type of breakfast (Japanese or Western), drinking habits, how often fish, vegetables and sweets were eaten, and about the frequency of using vegetable oil and water.

Blood and urine samples were collected from a total of 2,283 policemen in August and September 1971. A few milliliters of blood from each person were used for the hematological study by a Technicon Analyser. The remaining ten milliliters of blood and urine specimens from spot samples were stored in a deep freezer. Lead in blood and urine was measured by the mixed-colour dithizone methode. The hematological study included the measurements of hematocrit, red corpuscles, and hemoglobin.

RESULTS

Aerometric results

Figure 2 shows the overall average of aerometric data from the total eleven sampling stations, while Figure 3 shows this data from the ten sampling stations in Tokyo (except Hachijo Island). The general seasonal

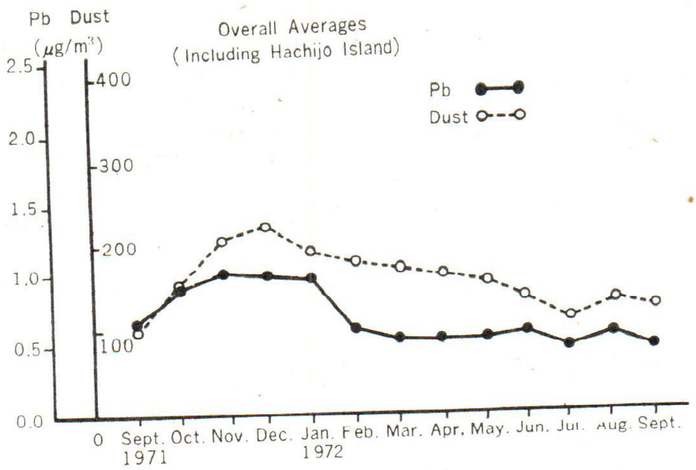

Fig. 2. *Lead and dust concentrations by month*

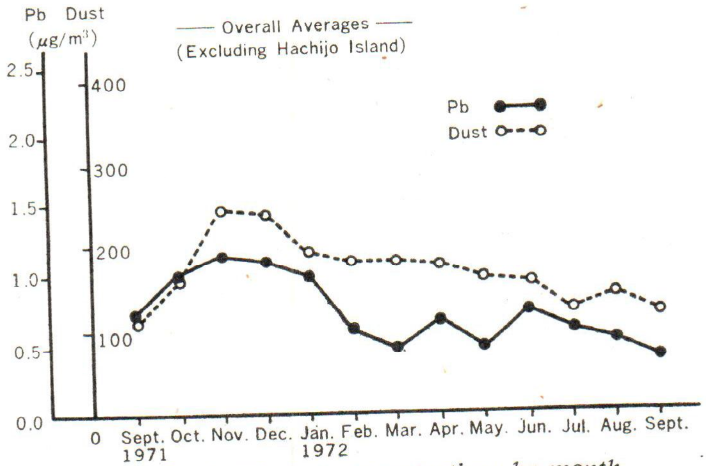

Fig. 3. *Lead and dust concentrations by month*

distribution indicates a higher concentration of lead during the months of October through January. Lead concentration was about 1 μg/m³ during these months but about 0.5 μg/m³ during the rest of the year. However, there were considerable variations in the seasonal pattern according to site. For example, larger variations were observed in the daily concentration at downtown sites than those of the suburbs. There was one site called Honden which presented extraordinarily large fluctuations, reaching a maximum of 10 μg/m³ and a minimum of 0.2 μg/m³. It was suspected that there may have been an industrial firm near the Honden station which periodically emitted lead into the air.

In general, however, the aerometric data showed higher concentrations of lead in the central areas of Tokyo than in the suburbs. Lead concentration in the air was about 1.0 μg/m³ in the central areas, about 0.4 μg/μ³ in the suburbs, about 0.2 μg/m³ on the outskirts of Tokyo, and approximately 0.02 μg/m³ in the Hachijo area. This data is shown in Table 2.

Table 2

Overall mean concentrations of lead and dust in air by sampling site, Tokyo*

Sept. 1971 — Sept. 1972	Sampling site (Police station)	Pb (μg/m³)	Dust (μg/m³)
Center of Tokyo	Headquarters	0.783	174
	Atago	0.798	181
	Shibuya	0.998	190
	Arakawa	1.011	218
	Honden	1.302	227
	Ogikubo	0.746	154
Suburb of Tokyo	Tanashi	0.507	143
	Machida	0.399	140
	Hachioji	0.426	155
	Itsukaichi	0.198	86.6
Island (remote)	Hachijo	0.024	49.4
	Average	0.654	156.0

* Unweighted means

Finally, as shown in Table 3 there was a very close relationship between lead concentration and the amount of dust in the air at the time of the study. According to this data I believe dust is an important source of lead in the atmosphere.

Biological results

Table 4 shows the mean value of the biological measurements of Tokyo policemen according to place of work, residence, and type of duty. Nearly all individual measurements were within »normal« ranges. However, there were ten persons with blood lead levels exceeding 40 μg/100

Table 3

Overall mean concentrations of lead and dust in air by month, Tokyo*

Month	Year	Including Hachijo Island		Excluding Hachijo Island	
		Pb ($\mu g/m^3$)	Dust ($\mu g/m^3$)	Pb ($\mu g/m^3$)	Dust ($\mu g/m^3$)
Sept.	1971	0.67	106	0.73	114
Oct.		0.90	150	0.99	162
Nov.		1.03	206	1.13	224
Dec.		1.00	222	1.07	239
Jan.	1972	0.97	191	0.97	191
Feb.		0.59	180	0.59	180
Mar.		0.43	170	0.47	162
Apr.		0.52	163	0.67	176
May		0.43	155	0.47	162
June		0.58	142	0.64	152
July		0.48	107	0.52	113
Aug.		0.61	134	0.51	142
Sept.		0.43	125	0.47	132

* Unweighted means

Table 4

Mean value of the biological measurements of Tokyo policemen by place of work, residence, and type of duty

Measurements	Hachijo	Place of work		Residence		Duty	
		Suburbs	Center city	Suburbs & other prefect.	Center city	Indoor	Outdoor
Ht %	46.3	45.9	45.7	45.7	45.7	45.3***	45.8
Rc in 10,000	484.1	489.4	485.5	485.6	485.6	477.0***	487.9
Hb g/dl	15.7	15.7	15.4	15.4	15.4	15.2****	15.4
PbB $\mu g/100$ g	17.0	16.8*	18.4	17.2**	18.7	17.8	18.1
ALA mg/l	2.28	2.11*	1.93	1.97	1.95	1.87	1.98
PbU $\mu g/l$	87.8	12.1	12.0	11.6**	12.3	11.1****	12.2

* Difference by place of work, $p < 0.01$
** Difference by place of residence, $p < 0.01$
*** Difference by type of duty, $p < 0.01$
**** Difference by type of duty, $p < 0.05$

ml, three with ALA of more than 6 μg/l, and one with a urine level of more than 80 μg/l. As shown in Table 4 the blood lead level in the policemen from the city center was significantly higher than that in suburban policemen, according to place of work as well as residence. There was no difference by type of duty. However, the average blood lead level in Hachijo was slightly higher than that in the suburbs. The maximum difference of the average was only 1.9 μg/100 g.

Figure 4 shows the trend of blood lead. There is a general tendency for a little higher blood lead level in the city than in the suburbs. On the contrary, urine lead reveals a somewhat different pattern than that for blood lead, as shown in Figure 5.

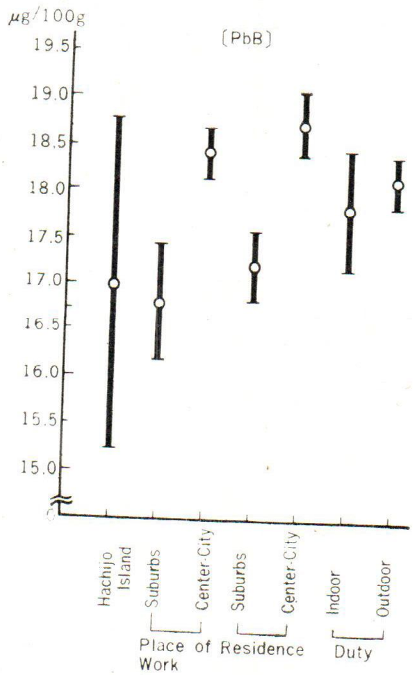

Fig. 4. *Mean values and 95 percent confidence intervals of PbB of Tokyo policemen by place of work, residence and type of duty*

Figure 6 shows ALA in urine by place of work, residence, and type of duty. It is interesting to note that the ALA values for Hachijo Island and the suburbs as places of work are higher than the other factors considered in this study.

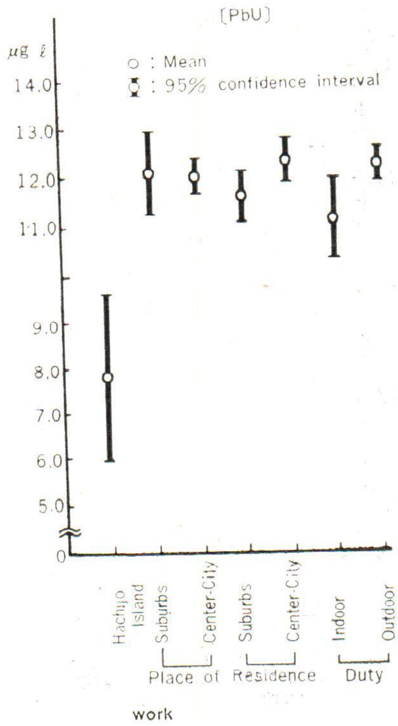

Fig. 5. *Mean values and 95 percent confidence intervals of PbU of Tokyo policemen by place of work, residence and type of duty*

As shown in Figure 7, hemoglobin reveals quite a similar pattern to that of ALA. It seems that a higher ALA in urine may be an indication of increased hematopoiesis, relating to the age factor.

Table 5 shows the mean values of biological measurements by age.

Hematocrit values were significantly higher in the policemen under 30 than in those over 40. However, lead in urine and blood did not disclose any difference by age. ALA values were higher in the younger groups, although no statistically significant difference was observed.

Table 6 shows the mean value of biological measurements in relation to smoking habits. Although there was no statistically significant difference according to the number of years of smoking, there was a tendency towards a slightly higher blood lead level in those who had been smoking for a long period of time as well as in those who smoked a larger number of cigarettes per day.

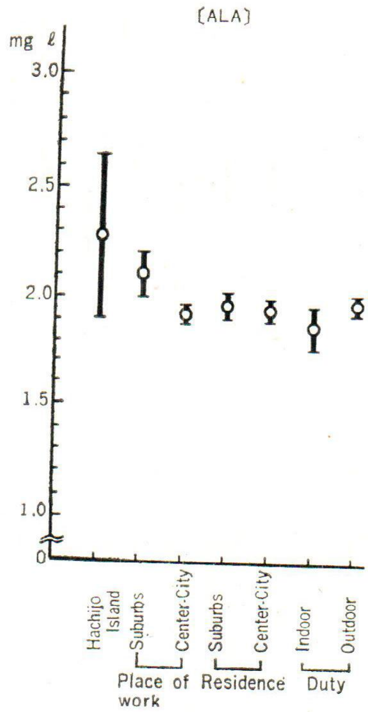

Fig. 6. *Mean values and 95 percent confidence intervals of ALA of Tokyo policemen by place of work, residence and type of duty*

Table 5

Mean values of the biological measurements of Tokyo policemen by age

Measurements	Age		
	Less than 30	30—39	40 & over
Ht	46.3**	46.0**	45.1
Rc	499.3**	489.0**	473.8
Hb	15.6**	15.5**	15.1
PbB	18.2	17.4	18.2
ALA	2.12	1.98	1.82
PbU	12.1	11.7	11.9

** For below 30, at least one contrast is $P < 0.01$
For 30—39 years, the contrast with 40 & over is $P < 0.01$

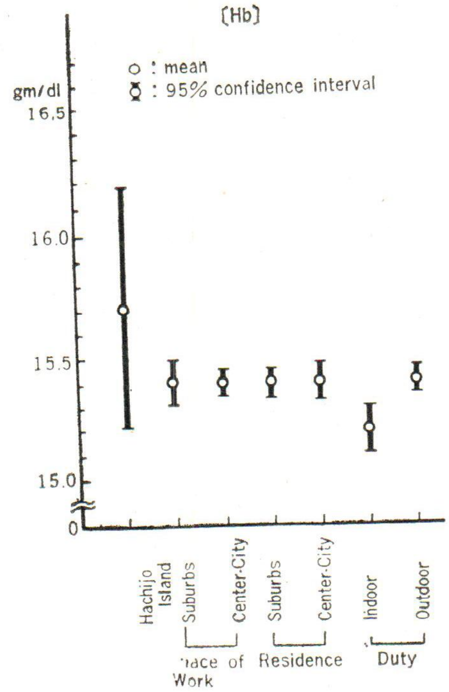

Fig. 7. *Mean values and 95 percent confidence intervals of hemoglobin level of Tokyo policemen by place of work, residence and type of duty*

Table 6

Mean values of the biological measurements of Tokyo policemen by present smoking habits

Measurement	Do not smoke	No. of years of smoking: Less than 5	5—9	10—14	15 & over	Number of cigarettes: Less than 10	10—20	20—30	30 & over
Ht	45.4	46.4	46.4	46.0	45.3	45.2	45.8	46.2	45.9
Rc	490.7	501.5	493.4	485.5	473.1	483.9	484.0	486.4	484.2
Hb	15.3	15.6	15.6	15.4	15.2	15.2	15.4	15.5	15.4
PbB	17.6	18.1	18.2	18.0	18.3	17.5	18.3	18.2	18.7
ALA	1.90	2.23	2.01	1.90	1.87	1.88	2.00	2.02	1.87
PbU	11.4	12.4	11.6	12.1	12.2	11.8	11.8	12.7	12.7

Table 7 deals with drinking habits. Heavy drinkers, i.e., those who drink about 700 milliliters or more of sake per day, obviously have a higher blood level than the other groups. It is not known whether or not this observation was made by chance.

Table 7

Mean values of the biological measurements of Tokyo policemen by drinking habits

	Do not drink	Amount drink each day				
		Occasionally	1 »Go«	2 »Go«	3 »Go«	4 »Go« & over
Ht	45.2	45.8	45.6	45.7	45.7	47.5
Rc	485.4	491.7	479.6	474.4	473.2	492.0
Hb	15.2	15.4	15.4	15.3	15.4	15.8
PbB	17.7	18.0	18.3	18.4	17.8	22.6
ALA	1.97	2.03	1.83	1.87	1.98	1.60
PbU	12.0	12.1	11.7	11.8	11.0	10.3

Remarks: 1 »Go« = 180 ml

There were no differences in most of the values measured which could be associated with the degree of consumption of selected food items.

As shown in Table 4, when subjects are divided by type of duty only, all hematological indicators, but no lead indicators, revealed statistically significant differences, showing higher values for the outdoor workers. However, outdoor duty policemen are, on the average, much younger than the indoor workers. Therefore, when age is fixed, all significant differences in the hematological measurements disappear; instead, the values of lead in urine for the outdoor workers in the higher age group become statistically higher than for the indoor workers. Nevertheless, when the history and amount of smoking is fixed, these differences disappear. Thus, we can conclude that even though outdoor duty policemen are more exposed to the ambient lead than the indoor workers, the type of duty does not seem to influence the levels of lead indicators, except for older policemen working in the city center. Even among the older policemen, however, the differences are subtle.

Table 8 shows the correlation matrix between biological measurements and age in the entire sample. As can be expected, the correlation between hematological measurements is very high. Among lead indicators, the correlations are not as significant. Even between the two lead levels — blood and urine — the correlation was only 0.10. However, it is significant in the sense that it is different from the zero correlation.

Table 8

Correlation matrix among the biological mesasurements and age total sample

Ht	Rc	Hb	PbB	ALA	PbU	Age
1.000	.779**	.928**	.108	.029	—.008	—.206**
	1.000	.766**	.094**	.033	—.036	—.331**
		1.000	.116**	.066**	—.066	—.232**
			1.000	—.038	.103**	.016
				1.000	.321**	—.142**
					1.000	—.012
						1.000

* P < 0.05
** P < 0.01

Although positive correlations of hematological measurements with lead in blood are significantly different from the zero correlation, the actual correlation does not exceed 0.116. This is a reasonable finding because most lead in blood is found to be bound to the red cells.

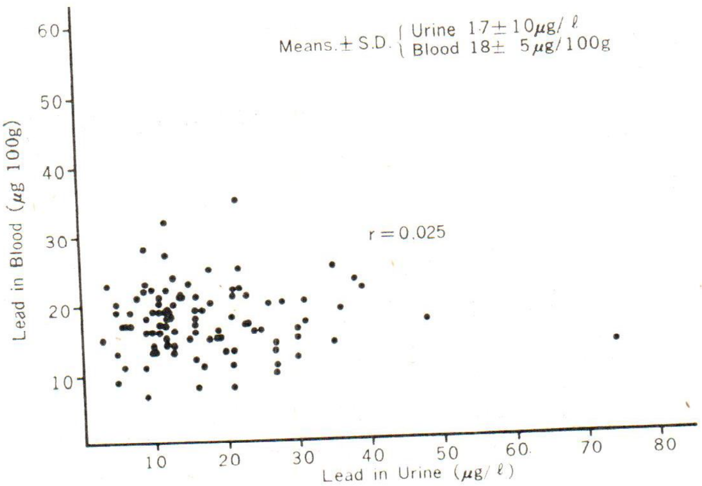

Fig. 8. *Correlation between blood lead and urinary lead concentration*

The correlation of hemoglobin with ALA although small is slighly significant. Since ALA is a precursor of hemoglobin, this perhaps is a reasonable observation. Age is in no relation to blood and urine lead levels, but shows a significant negative correlation to all the hematocrit measurements and ALA, especially with regard to red cells.

In 100 measurements of ALA, lead in blood and urine were randomly selected from the total measurements. The scatter diagrams showing associations among biological parameters are presented in Figs. 8, 9 and 10. Correlations do not appear except between lead in urine and ALA. This means that since these two tests use the same specimen, a large part of the correlation may merely reflect the influence of specific gravity of the urine specimen analysed.

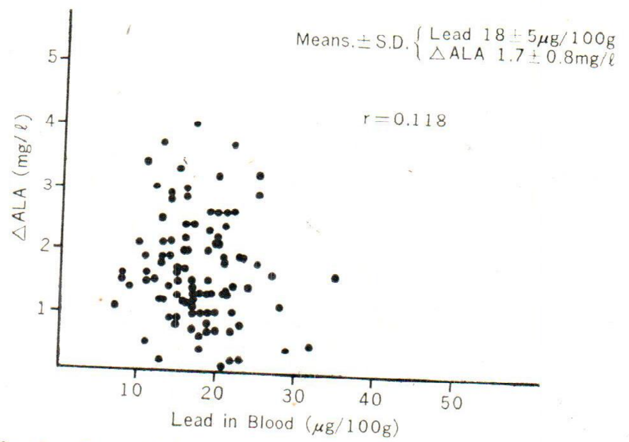

Fig. 9. *Correlation between blood lead and ALA in urine*

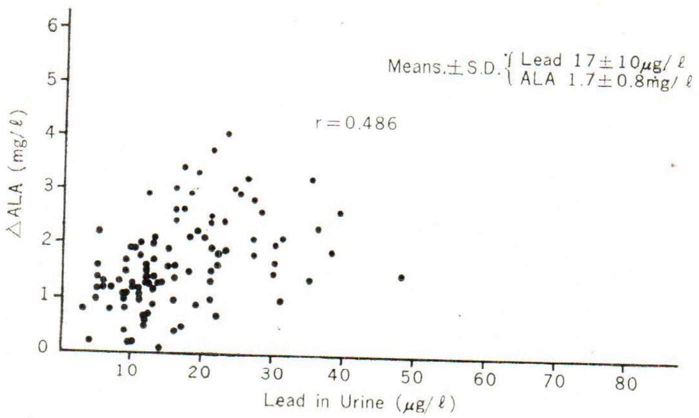

Fig. 10. *Correlation between urine lead levels and ALA in urine*

Figure 11 shows the five zones into which Tokyo was divided in the present study. The density of human and automobile populations increases as the zone number ascends. Furthermore, in the study of the association between the air lead concentration of various zones and the blood lead level of the subjects, an attempt was made to divide Tokyo into small segments in order to secure homogeneous samples for observation. Figure 12 shows the locations of the nine areas which correspond to the sampling station.

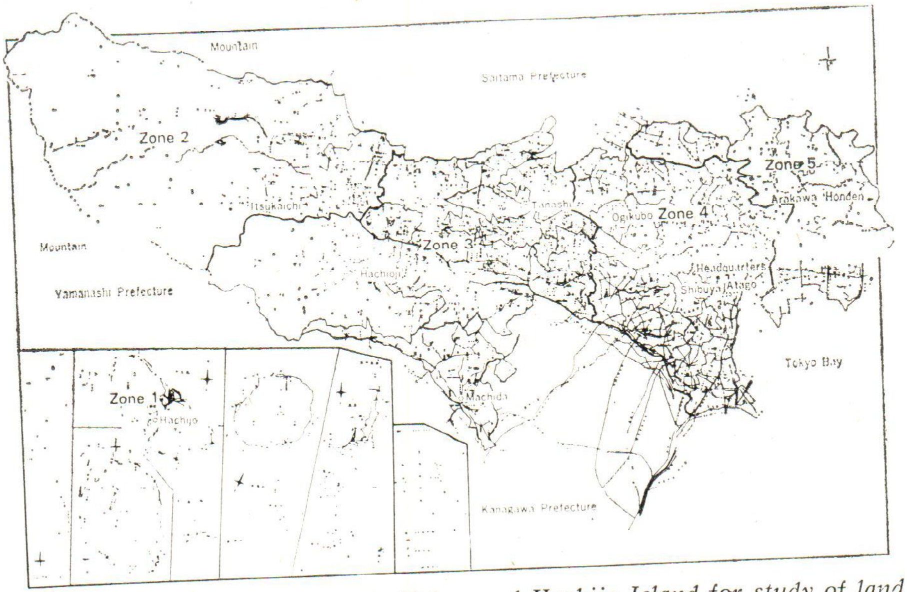

Fig. 11. *Fire zones established in Tokyo and Hachijo Island for study of land exposure*

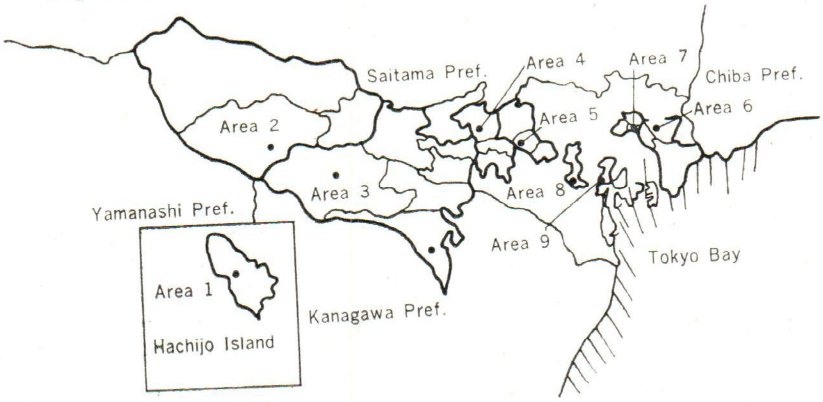

Fig. 12. *Map showing the locations of aerometric stations and area*

Figure 13 shows a scatter diagram of blood lead levels and air lead concentrations according to zone and area along with those from the »Seven City Lead Study« by *Tepper* and *Levin* in U.S.A. (5). It seems that there are no significant correlations between lead concentration in the air and blood lead level for U.S.A. It appears, however, that the Japanese data show a somewhat positive correlation between air lead level and blood lead level. Nevertheless, if one or two points are omitted from the figure, our data are very similar to those of the »Seven City Lead Study«. Therefore, one may be led to believe that this is a chance correlation, a belief which is supported by other observations in our study as well.

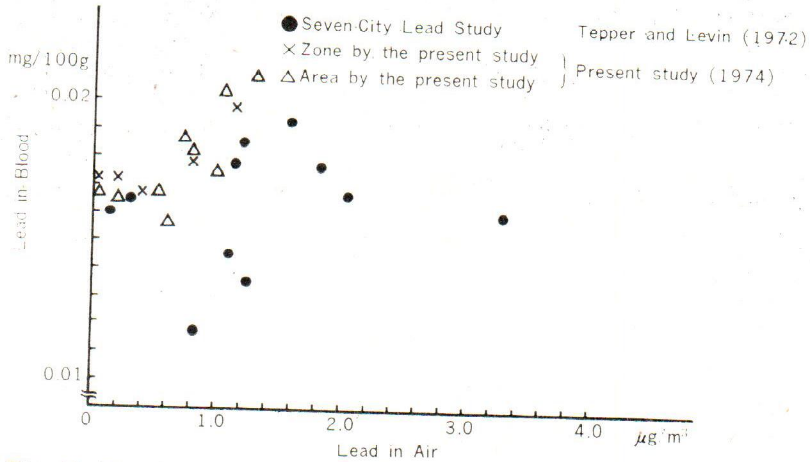

Fig. 13. *Blood lead levels and corresponding mean air lead levels*

CONCLUSION

In conclusion, the overal mean atmospheric lead concentration as determined in our study was 0.65 $\mu g/m^3$ which is far less than the levels observed in U.S. cities. There was a clear tendency toward increases in the lead concentrations as the site moved toward the center of the city. The island of Hachijo revealed a level less than 4 percent of the Tokyo average. There were higher concentrations during the fall/winter months and higher variations in the city center than in the suburbs. There was a high degree of parallelism between the concentrations of lead and dust in the air. In general, higher lead proportions were observed during the time and in the area of higher dust concentrations.

All the biological measurements were within normal ranges. In general, lead indicators differed significantly by place of work or residence, but the hematological measurements differed significantly by age and many other variables. The blood lead levels increased with urbanization. The difference was not large, but it was statistically significant. Hachijo Island showed much lower mean urine lead levels than the Tokyo areas in spite of the same levels of lead in blood.

There are several other factors related to the level of lead in blood and urine, such as smoking habit, type of duty (outdoor or indoor), and the amount of water and vegetables consumed. However, the association of these factors with blood and urine lead levels became noticeable only among older persons. The reason for this observation cannot be explained.

In any case, these variables accounted for only small portions of the total variations in lead indicators according to the multiple regression analysis, thus suggesting complex biological-environmental interactions with lead levels in blood and urine. By adding hematological measurements as independent variables, there were some small increases in the proportions of lead in blood and lead in urine variations explained.

Although hematological measurements were highly correlated, there were either no correlations or very small correlations among lead indicators. The performance of ALA measurements frequently resembled that of hematological measurements when analyzed by the factors considered in our study. The overall correlation coefficient between ALA and blood lead level was not significant. The ALA test may be a good indicator for the measurement of lead exposure only when such exposure is extremely high, as in occupational exposure; otherwise it may simply represent the activity of hematosyntheses.

In conclusion the present study revealed that the blood lead level is associated with many variables and factors. A higher blood lead levels observed in urban areas cannot be explained only by a higher lead concentration in the urban area in Tokyo where the overall average was about 1 $\mu g/m^3$ through 13 months from September 1971 to September 1972.

REVIEW OF ADDITIONAL STUDIES ON LEAD LEVELS IN JAPAN

In 1971 and 1972 some Tokyo inhabitants who were concerned about possible health effects of lead — whether or not they were actually affected by lead in the ambient air — came to local health departments in Tokyo to receive a detailed health examination. All the data collected by the health centers were statistically analysed by *Tsuchiva* and coworkers (3) and reported to the government of Tokyo in 1972. There were no observations which showed a possible relationship between the lead level in the ambient air and that in blood. The biological measurements in this study were carried out by the Tokyo Metropolitan Institute of Health Laboratory and the Occupational Health Service Center Laboratory.

Table 9 shows the averages of blood lead and urine lead by sex according to the health center data. The blood lead level in males was higher than in females, males having almost 15 μg/100 g and females about 11 μg/100 g. The mean levels of blood lead by ward were from approximately 9 μg/100 g to almost 17 μg/100 g, and that of lead in urine from approximately 6 μg/l to 22 μg/l on the average. This indicates that the values are rather arbitrary and the data obtained are insufficient for any scientific evaluation. Even the observation in which correlations between blood lead level and distance from the main street with heavy traffic are drawn up resulted in a negative conclusion regarding the possible health effects of lead in the air. This study showed very clearly that one must be very careful in designing a study as well as in choosing analytical methods and biological parameters of lead when dealing with lower level lead exposures.

Table 9

Levels of blood lead, urinary lead, urinary coproporphyrins and ΔALA in urine of Tokyo inhabitants

	PbB μg/100g		PbU μg/l		Copro μg/l		ΔALA μg/l	
	average	S. D.	average	S. D.	average	S. D.	average	S. D.
Total for 1970 & 71	** 13.06	7.56	** 12.39	10.18				
Male	14.98	7.98	13.12	10.26				
Female	11.22	6.64	11.70	10.06				
For 1970	** 12.12	6.31	** 12.06	9.19	** 50.00	39.67		
Male	13.72	6.58	12.89	9.59	54.37	44.26		
Female	10.38	5.50	11.15	8.65	44.94	32.94		
For 1971	** 14.06	8.56	* 12.73	11.10			** 1.84	0.90
Male	16.52	9.20	13.39	11.00			1.98	0.96
Female	12.01	7.47	12.18	11.16			1.72	0.83

* Significant difference between male and female ($p < 0.05$)
** Significant difference between male and female ($p < 0.01$)

The study recently reported by *Kodama* and coworkers (1) covered about 100 residents of both sexes and compared blood lead levels in a heavy traffic section and a suburban area of Fukuoka City on Kyushu Island. The atmospheric lead levels were 5.65 μg/m³ to 1.33 μg/m³ along the roaside, and less than 1.0 μg/m³ in the residential area. The arithmetic mean lead levels in the blood of men and women near traffic intersection were 14.9 μg/100 g and 10.0 μg/100 g respectively, and in the suburban area they were 12.1 μg/100 ml for men and 10.6 μg/100 ml for women. The difference between the geometric mean lead levels in the two groups was not significant. On the contrary, on the island of Okinawa, according to *Kodama* and coworkers (1) the atmospheric lead concentration was less than 1.0 μg/m³, but the average concentration of lead in blood was 18.8 μg/100 g and 14.4 μg/100 g in 28 men and 28 women respectively.

Another study reported recently by *Okutani* and *Harada* (2) is related to higher exposure to lead in air. Several among twenty school children who lived within 300 meters from a factory where steel was produced from iron scraps had more than 40 μg/100 ml of lead in their blood. The authors estimated that the lead concentrations in the air about five years prior to their investigation could have been about 60 to 70 μg/m³. However, it was only 20 μg/m³ at the time of the study, because the factory had improved the condition of the smoke stacks so that the pollution level was not as high as it had been. They reported that, in general, the children showed a higher level of blood lead than the adults. In this area of high exposure, they reported increased ALA in urine values in some inhabitants.

There are only a limited number of studies in Japan which show a dose-effect relationship between lead levels in air and in blood. However, when the few available data are reviewed there is no evidence that there is a dose-effect relationship between blood lead level and lead concentration in air of up to about 2 μg/m³. It seems that if there is any difference on a group basis in blood lead levels, living habits such as food consumption, cigarette smoking, and other unknown factors would be more important in influencing the level of blood lead than the atmospheric lead would be if it were less than a few micrograms per cubic meter.

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Sažetak

ISPITIVANJE KONCENTRACIJA OLOVA U ZRAKU I U LJUDIMA U JAPANU

U lipnju 1970. godine u japanskom tisku pojavili su se izvještaji u kojima se javljalo o masovnim otrovanjima olovom u ljudi koji žive u jednoj četvrti Tokija s gustim prometom. To je bio povod da se provedu temeljita istraživanja sa svrhom utvrđivanja mogućih odnosa nivoa olova u zraku i organizmu s jedne strane i mogućih učinaka tog olova na ljudima.

Za ova su istraživanja odabrana 2283 policajca iz Tokija i s jednog malog otočića 300 km od Tokija gdje je promet vrlo slab. Laboratorijski testovi uključivali su mjerenja hematokrita, eritrocita i hemoglobina, te olova u krvi i mokraći i delta-aminolevulinske kiseline u mokraći. Posebnim upitnikom od svih ispitanika uzeti su podaci o navikama pušenja, pijenja alkohola i uzimanja lijekova.

U toku 13 mjeseci uzimani su uzorci zraka na 11 mjesta u Tokiju kao i na spomenutom otočiću, i to kontinuirano po 24 sata tijekom 3 uzastopna dana u tjednu.

Rezultati su pokazali da je prosječna koncentracija olova u zraku bila 0,65 $\mu g/m^3$. Osim u rijetkih iznimaka, srednja koncentracija olova u krvi kretala se od 16,8 do 18,7 μg/100 ml ovisno o području rada ispitivane skupine policajaca. Samo je u desetorice ispitanika nivo olova u krvi premašio 40 μg/100 ml. U mokraći je količina olova iznosila prosječno 11,1 odnosno 12,2 μg/l (a samo je u tri osobe koncentracija bila viša od 18 μg/l). Koncentracija delta-aminolevulinske kiseline u mokraći bila je otprilike 2 mg/l, i to nešto viša u policajaca koji su radili u pregrađima i na otočiću bez prometa. Korelacija između atmosferskog olova, olova u krvi i delta-aminolevulinske kiseline u mokraći bila je vrlo slaba.

U zaključku se može istaknuti da osim u slučajevima kada onečišćenje okoline uslijedi iz nekog poznatog jakog izvora nema dokaza da bi olovo u zraku proizvelo u Japanu ikakve biološke učinke u općoj populaciji.

Istraživanja drugih autora provedena na 3500 stanovnika Tokija te neka druga istraživanja na manjim skupinama eksponiranih osoba, potkrepljuju ove navode.

DISCUSSION FOLLOWING THE PAPER

WILLIAMS: If one takes industrial experience that exposure to the old TLV of 200 μg Pb/m^3 for 40 hours a week produces a mean blood lead of 70 μg/100 ml., then eposure to an air lead of 4 $\mu g/m^3$ in a city street would be expected to produce a blood level elevation of 1—4 μg/100 ml depending on length of exposure.

TSUCHIYA: I believe that such an »extrapolation« should not be applied for a biological phenomenon. The association between two parameters in biological phenomenon is not linear, in general. Even if a high correlation coefficient is shown in a higher exposure, for example, between blood lead and ALA in urine, the latter stays almost normal until blood Pb increases up to 40 to 50 μ/100 ml. In addition, »industrial exposure« should be remembered to be quite different from »general population exposure«.

ZIELHUIS: From health point of view it is more important to study the percentile distribution of biological parameters than average levels. Is there any relation between lead in air and % subjects with PbB > 20, > 25, > 30 μg/100 ml?

TSUCHIYA: I know such a type of statistical procedure. But, according to our preliminary examination it was found that the distribution had fitted to »normal distribution«. Therefore, the same result will be obtained, if the method you suggest is applied to our data.

BERLIN: Population blood lead levels in the Japanese study are reported as arithmetic means while in the »Seven City« study geometric means were used. These different approaches are justified in view of the differences in population distributions but render direct comparison difficult. By presenting the results as frequency distributions the problem would be solved and one would also have better information on the abnormally high levels measured, of particular significance from the public health point of view.

TSUCHIYA: My answer to your question is almost the same as response to Dr. Zielhuis' question. Since our data showed a »normal distribution« curve, we used arithmetic means. However, we can recalculate our data according to your suggestion.

FUGAŠ: Although I do agree that at low concentrations of lead in air the possible differences in blood lead due to differences in air lead exposure are masked by the variations in oral lead intake. An additional reason for the lack of meaningful differences may be the fact that the actual inhalation exposure are often lower than estimated from the outdoor air lead concentrations.

Our earlier investigation has shown for instance that traffic policemen exposed in the average to 8.5 $\mu g/m^3$ while on duty, have an actual weighted average exposure to lead in air of 2.5 $\mu g/m^3$ since they live in a suburb with about 0.5 $\mu g/m^3$ of lead in air.