J. Natn. Sci. Coun. Sri Lanka 1996 24(2): 121-126

BLOOD LEAD LEVELS IN A POPULATION EXPOSED TO VEHICLE EMISSIONS

C.MALINI AREWGODA* and M.S.PERERA
Department of Chemistry, University of Kelaniya, Kelaniya.

(Received: 21 November 1995; acceepted: 12 January 1996)

Abstract: Over 99% of atmospheric lead in urban areas is due to petrol lead emissions. Blood lead levels in traffic policemen, street vendors, drivers of three wheelers, motor cyclists and school children in the Colombo metropolitan area were studied. Some of the general population who are least exposed to vehicle emissions were used as controls. They were selected from a village in Mirigama area after interviewing. Atomic absorption spectrophotometric method with graphite tube atomization was used to analyse venous blood lead levels. The study showed significantly higher levels of lead in blood for the adult population who are exposed to vehicle emissions than controls. Blood lead levels were established as, Control (90 $\mu g\ dm^{-3}$) < Motor cyclists (120 $\mu g\ dm^{-3}$) < Street vendors (130 $\mu g\ dm^{-3}$) < Drivers of three wheelers (150 $\mu g\ dm^{-3}$) < Traffic policemen (530 $\mu g\ dm^{-3}$).

Key Words: Blood, Colombo, lead, pollution, vehicle emissions.

INTRODUCTION

Lead is added to petrol in the form of tetraethyl lead (TEL) and tetramethyl lead (TML) in Sri Lanka, while some of the other countries use non-leaded petrol. Diesel does not contain added lead. During the combustion of petrol lead is released into the atmosphere, principally as inorganic lead salts in aerosol form[1] that remain suspended in air for some time before settling. Thus people can breathe the lead directly, or through the polluted dust in the air.

It has been reported that there is a close relationship between lead levels in blood and petrol emissions.[1] Therefore this work was carried out to assess the blood lead levels of the population exposed to vehicle emissions. Unpublished data by Mathes *et al.* indicates that the average lead concentration in ambient air of Colombo Metropolitan area ranges between 0.20 to 0.55 $\mu g\ m^{-3}$. By considering these values the sampling areas were selected. The objective of this study was to assess for the first time, the blood lead levels of selected groups of population that are exposed to vehicle emissions within the Colombo metropolitan area.

METHODS AND MATERIALS

Traffic policemen, street vendors, drivers of three wheelers, motor cyclists and school children in the Colombo metropolis were studied. The analysis of the blood lead levels of the general population who are presumably least exposed to vehicle

---

The main findings of this paper were presented at the 51st annual session of Sri Lanka Association for the Advancement of Science, November 1995.

* Corresponding author

emissions was performed separately for comparison. This control group was selected from a village in Mirigama area after interviewing them. Eventhough the selection of subject groups was judgmental, random samples were collected within a given group. Since blood collected by venipuncture has a low likelihood of contamination compared to blood collected by fingerprick, venous blood was the preferred specimens for analysis and was used throughout the project. Atomic absorption spectrophotometric method with graphite tube atomization was used for measuring procedure.[2]

All reagents used in this work were analytical grade or better. All glassware including sample bottles were cleaned thoroughly. High quality lead standard solution was used for instrument calibration (BDH spectrosol grade 1000 mg/l). All venous blood samples were taken by a medical officer with 'precisionglide' sterile disposable syringes with 23 gauge needles. A venous sample of 2-3 ml human blood was taken from the test person. Immediately after sampling the blood was thoroughly mixed in pre-cleaned glass bottles with 4 mg of EDTA (anticoagulant) per 1 ml of whole blood. The samples were swirled for 1 minute and stored in ice and transported to the laboratory. 1.0 ml aliquot of blood and 1.0 ml of the matrix modifier Triton - X 100 (an alkyl phenoxy polyethoxy ethanol) were vigorously mixed by means of an electrical mixer for few minutes.[3] The samples were analysed on the same day or day after using electrothermal atomization. 10.0 µL aliquot of these mixtures was directly injected into the instrument. Triplicate measurement of each standard and sample was performed. The volume of the matrix modifier was changed in certain cases due to the high concentration of lead present in blood samples. Preliminary measurements were made in order to set up the best instrumental conditions. Prior to sampling the consent of all the adult subject groups were obtained. Only the voluntary blood donors were sampled. For school children written consent of their parents was obtained before the sampling.

To set up the best analytical conditions for the drying and ashing steps, some preliminary measurements were made. Temperature and duration of the drying period were found to be crucial factors to avoid splattering. For 10 µL samples the following temperature progrmme was used throughout:

Step 1	Drying I	90⁰C	10 s	Ramp	4 s	Hold
Step 2	Drying II	130⁰C	40 s		10 s	
Step 3	Ashing I	650⁰C	30 s		50 s	
Step 4	Ashing II	650⁰C	51 s		11 s	
Step 5	Atomization	2200⁰C	1 s		8 s	
Step 6	Cleaning	2650⁰C	1 s		6 s	
Step 7	Cooling	40⁰C	21 s		20 s	

RESULTS

Table 1: Average age, height, weight and years of service for different subject groups.

Subject Group	No.	Age (yrs)		Height (cm)		Weight (kg)		Years of Service	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range
School children	29	9.4	9-10	61.2	43-122	48.4	44-52	Not applicable	
Motor cyclists	13	30.8	26-38	162.8	158-172	50.8	38-67	8.3	4-19
Street vendors	26	26.1	12-53	115.8	89-155	63.2	59-70	8.1	1-35
Drivers of three wheelers	15	32.9	21-47	131.3	104-175	60.3	55-65	5.6	1-12
Traffic policemen	27	35.5	24-52	170.9	102-226	67.1	64-71	9.5	2-31
Control for the adult group	25	35.9	18-65	126.8	102-158	65.6	62-73	Not applicable	

Table 2: Correlation Coefficients between lead concentration in blood and age, weight and years of service for different subject groups.

Subject Group	Concentration of lead in blood vs		
	Age	Weight	Years of Service
School children	0.1024	-0.0915	Not Applicable
Motor cyclists	-0.3512	0.1553	-0.3685
Street vendors	-0.2501	0.0876	-0.0958
Drivers of three wheelers	0.0042	-0.4081	-0.2388
Traffic policemen	-0.4053[a]	-0.1410	-0.3880[a]
Control for the adult group	0.0210	0.1273	Not Applicable

[a]$p < 0.05$

Table 3: Lead concentration in blood.

Subject group	Lead in blood ($\mu g\ dm^{-3}$)				
	Mean	Std. error	Confidence interval	t_1	t_2
School children	50	4.0	50 ± 8		
Motor cyclists	120	11.7	119 ± 25	2.58[a]	1.68
Street vendors	130	10.7	126 ± 22	3.01[a]	2.41[c]
Drivers of three wheelers	150	11.6	151 ± 24	5.16[b]	4.42[b]
Traffic policemen	530	16.1	530 ± 23	24.74[b]	8.11[b]
Control adults	90	6.5	87 ± 13		
WHO value	100				

Significance of difference in mean of, test and control group (t_1), test and WHO value (t_2), were determined by the Student's t test.

[a]$p < 0.01$ [b]$p < 0.001$ [c]$p < 0.05$

DISCUSSION

Except for traffic policemen rest of the subject groups did not show any significant association between age, weight and years of service in their respective profession, suggesting that intake of lead into the blood stream is independent of these factors (Table 2). Traffic policemen however showed a low and negative correlation between lead in blood with age and years of service, suggesting that with the increase in age there appear to be a reduction in the lead uptake. This may be because there is a slightly higher intake of lead into the blood in the younger group[4] and perhaps the older policemen spent less time on duty. All the subject groups showed significantly higher levels of lead in blood as compared to controls (Table 3). The traffic policemen showed very high levels of lead in blood. In the absence of a suitable control group for school children it is difficult to make a conclusive statement. However in the broad sense , compared to a recent study[4] the lead in blood ($< 90\ \mu g\ dm^{-3}$) for school children could be reasonably stated to be on the lower side. Comparison of the lead levels in blood with the WHO value indicated the significantly higher levels of lead in certain subject group as indicated by the Table 3.

Acknowledgement

Authors wish to thank NAREPP/IRG for research support, Dr. R. de Alwis for assistance in sampling, the Ceylon Petroleum Corporation for analytical facilities and Cyril Suduwella for technical assistance. Our thanks are also due to D.T. Mathes of the Coconut Research Institute for help with statistical analyses.

References

1. Annest J. L. (1983). Trends in blood lead levels of the United States Population. In: *Lead versus Health* (Eds. M.J. Rutter and R.R. Jones) pp. 33-58. John Wiley and Sons, Chichester and New York.

2. Constantini S., Gierdane R. & Rubbian M. (1987). Comparison of flameless atomic absorption spectrophotometry and anodic stripping voltammetry for the determination of blood lead. *Microchemical Journal* **35**: 70-82.

3. Ramakrishna R.S., Ponnampalam M., Brooks R.R. & Ryan D.E. (1982). Blood lead levels in Sri Lankan families recovering gold and silver from jewellers waste. *Archives of Environmental Health* **37**(2): 118-120

4. William L.R. (1991). Preventing lead poisoning in young children. A statement by the centre for disease control. pp. 1-4, U.S.Department of Health and Human Services, Atlanta.