Effect of Environmental lead pollution on Blood Lead Levels in Traffic Police Constables in Islamabad, Pakistan

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Abstract

Objective: To determine the blood lead levels and trace elements (copper and manganese) in traffic police constables in Islamabad in order to assess the effects of environmental pollution on the levels of metals in body fluids.

Methods: Blood samples were collected from 47 male traffic police constables, 21 to 45 years of age, posted in different areas of Islamabad and controlling traffic from 3 months to 18 years, 8 hours/day, 6 days/week. Adolescent males (13-19 years), residing in comparatively clean and very low traffic areas were included as controls. Blood lead, copper, and manganese concentrations were estimated by atomic absorption spectrophotometry.

Results: The mean blood lead level among constables (27.27 µg/dl) was significantly ($p<0.0001$) high as compared to controls (3.22 µg/dl). Twenty one percent constables had elevated blood lead levels (over 25 µg/dl) and 13% had levels above the safety limit (40 µg/dl). No correlation was found between blood lead levels and length of service. No significant difference was found in the mean values for copper between traffic constables (93.49 µg/dl) and controls (71.15 µg/dl). The mean blood manganese levels in traffic constables (21.94 µg/dl) were significantly ($p<0.0001$) higher than in controls (1.70 µg/dl). The mean blood lead levels were significantly high in traffic constables of Karachi (47.7 µg/dl) as compared to Islamabad (27.2 µg/dl), which shows direct relation of rise in blood lead levels with vehicle exhaust.

Conclusion: Environmental lead pollution is associated with an increased blood lead concentration in those who are regularly exposed to vehicle exhaust in high traffic areas. The degree of lead pollution arising from vehicle exhaust differs in Karachi and Islamabad. Exposure to air containing dust particles rich in manganese may affect blood manganese levels (JPMA 55:410;2005).

Introduction

Lead is a recognized environmental pollutant. The combustion in vehicles of petrol containing antiknock additive lead has become a major source of atmospheric lead.[1]

Lead is inspired as small particulate matter, ingested in food and water, absorbed through lungs and gastrointestinal tract[2], and a certain amount is accumulated in bones and soft tissues.[3] Many variables in the absorption, storage and excretion of lead, modify the blood lead concentration (BPbL) in the body, and therefore, its effects. Lead absorbed via the gastrointestinal tract is excreted in faeces and via the kidneys, although at a slower rate. Blood lead level rise rapidly after a recent exposure only.[4]

Lead is a purely toxic element and theoretically its levels in any body fluid should be zero, which is not possible in an industrial society. The acceptable, no effect level is 10 µg/dl for children and 25 µg/dl for adults. Acute lead toxicity apparent by a blood lead level of 120 µg/ml in adults and 80 µg/dl in children may give rise irreversibly to increased cerebrospinal pressure, convulsions, memory loss, acute encephalopathy and death.[5] The adverse toxic effects of lead may cause anemia, GIT and renal problems, raised blood pressure, loss of I.Q (Intelligence Quotient) and learning disabilities.[6] Blood levels as low as 25 µg/dl may produce neurotoxic effects, such as dullness, irritability, restlessness, poor attention span, headache, muscular tremor, hallucinations and memory loss. Children are more sensitive to lead than adults because of their developing central nervous system, smaller body size, higher rate of absorption and tendency to put objects in their mouth.[7,8]

Various studies in Pakistan have shown high blood lead levels in different population groups.[9-13] In a previous study, it has been shown that traffic police constables working at various traffic control stations in Karachi who were regularly exposed to vehicle exhaust fumes in controlling traffic, had alarmingly higher blood lead levels (above the safety limits) as compared to common men.[9]

This study was conducted to determine the blood lead levels and trace elements (copper, and manganese) in traffic police constables working in Islamabad in order to assess the effects of environmental pollution on the levels of metals in body fluids. Also, to find the difference in the relationship between atmospheric lead pollution and blood lead levels in two cities i.e. Karachi and Islamabad.

Subjects and Methods

Blood samples were collected from 47 traffic police constables posted in different areas of Islamabad. The subjects were 21 to 45 years of age and controlling traffic from 3 months to 18 years, 8 hours a day, 6 days a week. All were males performing shift duties, and not on any medication. Young adolescent males, aged 13 to 19 years, who were residing in comparatively very low traffic areas were included as controls. Consent was taken prior to collection of blood sample from constables and controls.

Approximately 10 ml of blood was drawn from each subject by disposable plastic syringes. Samples (8 ml) were immediately transferred to acid washed eppendorf tubes containing 200 µl of 10% EDTA, while the remaining 2 ml were collected into another vial containing EDTA, for hemoglobin estimation. The EDTA solutions had been previously tested for the absence of metal under test. All water used was doubly deionized distilled water and was tested for zero response by Atomic absorption spectrophotometry for each element under test.

All glassware had been immersed in 20% nitric acid for four days, in most cases for several days, to ensure metal free surfaces and rinsed, at least for six times, in doubly deionized distilled water prior to use.

Blood lead, copper, and manganese concentrations were estimated in duplicate by atomic absorption spectrophotometry. The sample preparation was done by the method of Subramanian and Jean.[14] A Shimadizu Model 670 atomic absorption spectrophotometer equipped with 670G, a graphite furnace, a deuterium arc background corrector, a PR-4 printer; hollow cathode lamp (Hamamatus Photonics K.K., Japan) was used for analysis. Nitrogen is used as inert gas to provide inert environment. The entire analytical operation was performed in a complete sterile environmental to avoid any contamination.

Students t test was used to test the significance of mean difference.

Results

Forty-seven traffic police constables and 88 young adolescent males were investigated. Their ages ranged from 21 to 45 years and 13 to 19 years respectively.

Table 1 shows the mean blood lead, copper and manganese levels in traffic police constables and controls.

Table 1. Distribution of blood Lead, Copper, and Manganese levels (µg/dl) in Traffic Police Constables and Controls.

METALS	TRAFFIC CONSTABLES (n=47)		CONTROLS (n=88)	
(µg / dl)	MEAN ± SE	(RANGE)	MEAN ± SE	(RANGE)
LEAD	*27.27 ± 4.04	(7.6 – 108)	3.22 ± 0.198	(2.178 – 4.283)
COPPER	93.49 ± 0.47	(52 – 248)	89.88 ± 5.50	(71.154 – 108)
MANGNESE	*21.94 ± 0.80	(1.4 – 50.6)	2.233 ± 0.168	(1.70 – 2.169)

* p<0.0001 (student t test)

The blood lead levels ranged from 7.6 - 108.8 µg/dl with mean values 27.27 $\pm$ SE 4.04 µg/dl among traffic police constables. Of the total 47 constables, 22 (46.8%) had levels up to 20 µg/dl, in 9 (19.14%) constables the levels ranged from 20 to 25 µg/dl and 21% cases had levels of lead over 25 µg/dl. About 13% cases had blood lead levels above the safety limit (40 µg/dl). The mean blood lead levels found in controls were very low. The mean blood lead levels in traffic constables were significantly (p<0.0001) higher than in controls.

Table 2. Comparison of Mean Blood Lead and Haemoglobin Levels by age groups for Traffic Police Constables in Karachi and Islamabad.

Age Groups	Traffic Police Constables ISLAMABAD Mean ± SE (n=47)			Traffic Police Constables KARACHI Mean ± SD (n=121)		
(Years)	Service (Months)	Lead (µg/dl)	Hb levels (G/dl)	Service (Months)	Lead (µg/dl)	Hb levels (G/dl)
20-30	21.52 ± 0.69	28.27 ± 0.85 (30)	17.17 ± 0.04	46 ± 38.2	48.7 ± 17.2 (69)	13.9 ± 1.7
31-40	4.52 ± 0.37	29.18 ± 1.43 (14)	18.092 ± 0.06	106 ± 45.4	46.7 ± 14.8 (41)	14.1 ± 1.3
41-up	94.0 ± 33.0	14.86 ± 2.04 (3)	16.8 ± 0.266	183 ± 81.9	45.2 ± 6.9 (11)	14.8 ± 0.9

The mean copper levels (93.49 $\pm$ SE 0.47 µg/dl) were almost the same in police constables and the control (89.88 $\pm$ SE 5.5), where as the mean manganese levels (21.94 $\pm$ SE 0.80 µg/dl) among traffic constables were high as compared to controls. The difference in mean values for manganese between traffic constables and controls was also significant (p<0.0001) whereas, no significant difference was found in the mean values for copper between the two groups.

Table 2 shows the mean (±SE) values of blood lead, and haemoglobin levels at different age groups in Traffic Police Constables of Islamabad and Karachi and the mean (±SE) values for their length of services. No significant difference was found in mean blood lead values at various age groups in the present study. However, the levels were significantly ($p<0.0001$) high at all age groups in traffic constables of Karachi as compared to Islamabad. There was no correlation between blood lead levels and length of services. Haemoglobin levels were found to be normal in all age groups.

Table 3 shows the comparison of overall mean blood lead levels found in traffic police controllers in three different studies. Their length of services and duty hours are also shown. The highest mean levels were found in Alexandria, Egypt as compared to other two studies conducted in different cities of Pakistan. The mean blood lead levels were higher than the safety limits (40 µg/dl) in traffic controller of Alexandria, and Karachi.

Table 3. Mean and Range of Blood Lead levels in Traffic Controllers/Constables found in 3 different studies.

Traffic Controllers	No.	Age (Years)	Length of Service	Duty Hours	Mean Blood Lead Levels (µg/dl)	Range (µg/dl)
Alexandria[22], Egypt	45	20-60	Up to 40 yr	9 hrs/day, 6 days/week	68 (±SD13.0)	37-97
Karachi[11], Pakistan	121	20-52	One month to 25 yr	8 hrs / day, 6 days/ week	47.7 (±SD15.8)	23-152
Islamabad, Pakistan (Present study)	47	21-45	Three months to 18 yr	8hrs/day 6 days/week	27.27 (±SE4.04)	7.6-108

Discussion

The difference between blood lead levels in controls and traffic police constables leaves little doubt that regular exposure in high traffic areas is associated with increased blood lead concentrations. When compared with hemoglobin levels, no correlation was found between lead and hemoglobin in traffic police constables as reported by a similar study conducted in Karachi.[9]

There was no difference in mean copper levels between police constables and controls. Although the controls were younger in age as compared to constables but the mean values found in this study coincides with the values reported in normal adult males in Karachi[15] (mean 91.9 µg/dl) and in Bangladesh[16] (mean 98 µg/dl). However, the range for copper (52-248 µg/dl) in the present study was wider than observed for the adult population in Karachi (70-114 µg/dl) and coincides with that reported from Bangladesh (40-276 µg/dl), and Denmark[17] (71-255 µg/dl). It is seen that there is a very wide variation in the normal range quoted for copper in different parts of the world. The reason for the differences might be worldwide variability in copper intake. The copper content of the food is variable and depends on copper levels in the soil of different geographical areas. Lower copper levels in whole blood of normal populations have also been attributed to genetic variations in copper metabolism. The presence of dietary copper antagonist in the diet and the type of dietary carbohydrates consumption also affect the body copper levels.[18]

The result obtained for the blood manganese levels for traffic police constables was higher than controls. This difference may be attributable to exposure to air, which contains dust particles rich in manganese. Further, it has been reported that exposure to manganese in the environment may increase due to the use of the manganese containing compound methyclopentadienyl manganese tricarbonyl in gasoline as an anti-knock agent.[19]

Although safety limits for blood lead levels are still often quoted as being 40 µg/dl for adults and 30 µg/dl for children.[11] The European Committee decided on a mean acceptable value of 20 µg/dl[20] while 25 µg/dl regarded as elevated in U.S.A (Centre for Disease Control).[21]

The mean value for blood lead levels in the present study when compared with a similar study conducted in Karachi, it was found that traffic police constables in Karachi[9] had values much higher than in constables in Islamabad. Probably because Karachi is a populated city where traffic congestion and atmospheric pollution is high as compared to Islamabad.

Another study from Egypt reported a very high blood lead levels in Traffic Controllers of Alexandria, Egypt, Road Intersections.[22] The mean level was very high than the acceptable level of blood lead in adults and the levels found in present study and that reported from Karachi. Alexandria is the second most highly populated city in Egypt and the traffic controllers control traffic lights at road intersections manually, therefore the high blood levels could be attributed to lead emissions from motor vehicles.

The results were further substantiated by a study that was conducted to determine the lead, cadmium, copper and zinc in environmental samples (in soil sludge, sediment and grass samples collected from different areas of Rawalpindi and Islamabad) to find the effect of traffic and pollution through these elements.[23] The study reported that concentrations of zinc, copper and cadmium did not increase significantly, but level of lead increased many times, which showed that traffic caused lead pollution. To find out the range of lead pollution from traffic, samples were collected at different distances from road. It was found that lead pollution was near the road only and levels of lead decreased appreciably with the increase of distance from road.

In the present study, no difference in mean blood lead levels was observed in the traffic constables when grouped according to their length of services as reported by other studies.[9,22] This may be explained by the fact that the half-life of lead is 18 days, with a mean life of 28 days. Owing to this short half-life, a lead level in blood represents recent exposures only and does not necessarily indicate past exposure.

In Pakistan, major source of environmental lead pollution is vehicle fumes and is probably the major contributing factor to the high blood lead levels in those who are regularly exposed in high traffic areas. The results of this study have clearly shown the difference in the relationship between atmospheric lead pollution and blood lead levels in two cities i.e. Karachi and Islamabad. Therefore, there is a need of developing strategies to reduce the lead pollution by introducing lead free petrol, use of especially designed mufflers (silencers), and encouraging the use of CNG in vehicles.

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