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Short Communication

Lead and Cadmium Concentration in the Human Blood Samples of Muzaffarabad, AJK, Pakistan

Muhammad Hafeez,[1,*] Muhammad Naeem Ahmed,[1] Muhammad Mushtaq Farooqi,[1] Noor-ul-Ain Butt[1] and Abdul Rauf [2]
[1]Department of Chemistry, University of Azad Jammu & Kashmir, 13100 Muzaffarabad, Azad Kashmir, Pakistan
[2]Department of Zoology, University of Azad Jammu & Kashmir, 13100 Muzaffarabad, Azad Kashmir, Pakistan

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Authors' Contribution
MH has conceived and designed the study and written the article. MMF and NB have collected blood samples and performed the experimental work. MNA helped in data analysis. AR helped in preparation of manuscript.

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ABSTRACT

The blood samples of Muzaffarabad city from different walks of life were analyzed for concentration of lead (Pb) and cadmium (Cd). Low Pb and Cd levels were found in less exposed females which increased with increasing age. Comparatively higher Cd levels were found in elder females (3.53±0.37 µg mL^{-1}), elder males (3.42±0.66 µg mL^{-1}), auto workshop workers (2.92±0.64 µg mL^{-1}) and smokers (6.82±0.62 µg mL^{-1}).

Metals such as Pb and Cd have no physiological role in the human body but instead cause severe health problems (Koedrith *et al.*, 2013; Tchounwou *et al.*, 2012; Dorne *et al.*, 2011; Dubiella-Jackowska *et al.*, 2009). Cd is responsible for many health problems in human beings including respiratory, renal, cardiovascular and skeletal disorders (Tchounwou *et al.*, 2012). Itai-Itai disease, which affected thousands of people in Japan and even many lead to death, was caused by Cd (Baby *et al*., 2010). Pb metal has also severe effects on human beings including damage to central nervous system (Tarrago, 2010). Compared to adults, children are more prone to central nervous system damage. In addition to this, Pb also causes behavioral, hearing, developmental, kidneys and liver problems in children (Kim and Park, 2014). Nervous, hearing, reproductive, muscular and high blood pressure problems in adults have been correlated to Pb toxicity (Lustberg and Silbergeld, 2002). There are many natural and anthropogenic sources through which these metals are spread in water, air and enter into the human food chain (Tong *et al*., 2000). Unhealthy habits such as smoking also increases the levels of these metals in the human body and studies indicate that smokers have higher Cd and Pb levels as compared to nonsmokers (Benoff *et al*., 2009). The areas which are close to heavy industries and mining sites as well as big cities are more polluted with these metals and inhabitants of such areas have higher levels of these metals in their blood (Jarup, 2003).

* Corresponding author: smhafeezkhan@yahoo.com
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The basic purpose of this work was to determine the heavy metals Pb and Cd in the blood of residents of Muzaffarabad (A non-industrial city). The city population has been divided into less exposed (house wives), more exposed (shop keepers) and highly exposed (auto workshop workers and smokers) groups. The results of the present study are indicative of higher blood levels of Cd and Pb in city inhabitants.

Materials and methods

The blood (5 mL) was collected using sterilized plastic syringes and stored at lower temperature before acid digestion. Some soil samples have also been collected from the soil adjacent to workshops. These samples were collected from 0 to 5 cm from the top. Selected cigarette brands (based on market survey) were also considered for Cd analysis. Twelve brands of the cigarettes namely Gold Leaf, Capstan, Pine, Gold Flack, Red and White, Morven Gold, Master Blend, Pine Light, Special Filter, Dunhill, Marlboro and Bond Street were purchased form the local market. Blood samples for atomic absorption spectrophotometric analysis were prepared according to Yahaya *et al.* (2013), whereas the soil samples were prepared according to EPA Method 3050B. Cigarette sample solutions were prepared according to Levent *et al.* (2013). Atomic Absorption Spectrophotometer (Shimadzu, Japan), model no. AA 6300 was used for determination of Cd and Pb in the blood, soil and cigarette samples.

Results and discussion

Most of the females in Muzaffarabad are house wives and remain inside homes for most of the time. The females under survey were 18 to 62 years old. An

Table I.- Concentration (Mean±SEM) of Cd and Pb in blood samples of different segments of population of Muzaffarabad, AJK.

Age group	Females (n=10)		Shopkeepers (n=10)		Automobile workers (n=10)		Smokers (n=10) Cd ($\mu g\ mL^{-1}$)	WHO permissible limits ($\mu g\ mL^{-1}$)
	Cd ($\mu g\ mL^{-1}$)	Pb ($\mu g\ mL^{-1}$)	Cd ($\mu g\ mL^{-1}$)	Pb ($\mu g\ mL^{-1}$)	Cd ($\mu g\ mL^{-1}$)	Pb ($\mu g\ mL^{-1}$)		
18-40	0.95±0.18	0.11±0.05	1.76±0.18	0.09±0.02	1.48±0.14	0.81±0.03	1.86±0.32	0.004
41-62	3.53±0.37	0.05±0.00	3.42±0.66	0.15±0.04	2.92±0.64	0.93±0.13	6.82±0.62	0.1

increase in Cd and Pb concentration was observed with increasing age (Table I). Cd is absorbed more efficiently from lungs and digestive tract as compared to Pb and this might be the reason for higher Cd levels as compared to Pb levels (Swaran and Pachauri, 2010). An increasing concentration of Cd in the blood has been observed with increasing age. This population group is less exposed to air pollution, the higher blood Cd levels could not be related to drinking water and food only because normally the Cd levels in water and food in non-industrialized areas have been found low (Jarup, 2003). A probable explanation of increased Cd levels in this comparatively less exposed group is the diet pattern. The major diet of the people of Muzaffarabad is rice. It has been well established that Cd present in agricultural soils is absorbed by crops through water and rate of absorption has been found maximum for the rice crop (Cao *et al*., 2010). Another reason for higher Cd concentration could be the use of different cosmetics. Previous studies show higher levels of heavy metals in cosmetics and longtime use of such cosmetics may increase levels of toxic metals in the body (Khalid *et al*., 2013; Borowska and Brzóska, 2015). The toxic metals coming from cosmetics could enter into the body through oral and dermal routes. The food containing less calcium content may result in the higher concentration of Cd in non-exposed females (Sataruq and Moore, 2004). The higher concentration of Cd in the older people is probably due to diet deficient in calcium and zinc (Linder, 1985). Studies show that iron deficiency also increases Cd absorption from digestive tract (Kim and Park, 2014). Cadmium is also used as a stabilizer in plastics and rubber tires (Ashraf, 2012). Based upon relevant literature, it could be hypothesized that due to burning, environmental degradation of plastics and abrasion of tires, the Cd is coming into human body through air, water and food (Jarup, 2003). Blood Cd levels of non-exposed and nonsmoker's adults are approximately 0.004 $\mu g\ mL^{-1}$ (Hipkins *et al.*, 1998; Rempel, 1989; WHO, 1996). In comparison to this standard, the Cd concentration in the non-exposed as well as exposed people (including smokers) of Muzaffarabad city is much higher. These values are even higher when compared to similar studies conducted in Hyderabad city, Sindh, Pakistan (Afridi *et al*., 2010; Yousafzai *et al*., 2012).

The less exposed males (shop keepers) under survey were 18-62 years old. (Table I). An increase in Cd and Pb concentration was observed with increasing age. Although the Pb concentration is lower as compared to Cd blood levels, yet higher in comparison to permissible limit of Pb (0.1 $\mu g\ mL^{-1}$) in human adults (Hipkins *et al.*, 1998; Rempel, 1989; WHO, 1996).

Auto mechanic, welders and painters are more exposed to metals as compared to people staying at home. The lead levels in this group were found higher as compared to less exposed groups (shopkeepers) whereas the Cd levels were observed lower. These workers are involved in cutting, welding, cleaning, painting and repairing of cars and during these operations are exposed to Cd and Pb. The soil analysis of samples taken from vicinity of automobile workshops indicated higher levels of these metals (Table II). These values are much higher than the standards set by WHO for Cd and Pb in the soil (Zhao *et al*., 2014). Hence these workers are at higher risk of heavy metal toxicity.

Table II.- Concentration (Mean ± SEM) of Cd and Pb in soil and cigarette samples.

Sample	Pb ($\mu g\ g^{-1}$)	Cd ($\mu g\ g^{-1}$)	WHO permissible limits ($\mu g\ g^{-1}$)
Soil near workshops (n=7)	13.79±1.20	28.61±2.17	50 $\mu g\ g^{-1}$
Cigarettes brands (n=12)	-	2.90± 0.10	--

Tobacco contains naturally higher concentration of Cd metal and this metal along with smoke reaches the lungs of smokers and about 25 to 50 % of the total Cd reaching to lungs is absorbed (Levent *et al*., 2013). The

blood samples of smokers were also analyzed for Cd analysis (Table I) and as compared to other male groups, the Cd concentration was found higher (Table I). In addition to smoking, other factors such as food, water and dust containing Cd could also be responsible for higher Cd concentration (Jarup, 2003). But these Cd concentrations are higher as compared to exposed males (nonsmokers). Hence it could be assumed that comparatively higher blood Cd level in smokers is due to smoking.

Selected cigarette brands (based on consumer demand) were also analyzed for Cd levels. The cigarette contains higher amount of Cd metal because tobacco plant absorbs Cd more efficiently from soil and hence higher concentration is accumulated in tobacco leaves. The mean concentration of Cd in cigarette samples was found to be 2.904 μg g^{-1} (Table II).

Conclusions

In the present study, higher levels of Cd have been found in blood samples of people living in Muzaffarabad (a non-industrialized city). As compared to Cd, the concentration of Pb was found lower. To identify the sources of these metals, the soil samples as well as cigarette samples were analyzed and higher concentration of these metals were found. A regular increasing trend was observed for Cd with increasing age however this trend was not prominent in case of Pb. The present study aims to find a baseline concentration of these metals in human blood. Further studies are required to identify all the sources (water and food) of these metals in a non-industrialized city (Muzaffarabad). In addition to this, a detailed biochemical investigation of the city residents is required to assess the toxic effects caused by these metals and to take scientific and reasonable remedial measures.

Statement of conflict of interest

Authors have declared no conflict of interest.

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