Journal of Academia and Industrial Research (JAIR)
Volume 2, Issue 4 September 2013

ISSN: 2278-5213

RESEARCH ARTICLE

# Effect of Toxic Metal Water Pollution on Humans in Central India

**Deepak Sinha**
Dept. of Chemistry, Govt. N PG Science College, Raipur-492010, CG (India)
drsinha333@rediffmail.com; +91 9425290603

## Abstract

The present study analyzed the concentration of cadmium, selenium and zink in the water around the industrial area of Chhattisgarh state and its effect on the humans using this water as drinking sources on compression with the healthy controls which are using unpolluted water. For the present investigation three types of samples were collected. Water sampling: samples were collected from different polluted sites. Blood sampling from polluted area: The blood samples of 1000 randomly selected individuals from the villages of polluted area. Blood sampling from control sites: The blood samples of 1000 randomly selected individuals from the non-polluted area. Water and blood analysis were done by atomic absorption spectroscopy. The study found increased concentration of these three toxic elements in the polluted water as well as in individuals using this water than control found to be statistically significant (P<0.0001).

**Keywords:** Metal toxicity, pollution, drinking water, atomic absorption spectroscopy, blood plasma.

## Introduction

Heavy industrialization and increasing population have increased coal utilization in the Bilaspur district. Coal utilization produced flyash, flue gas and bottom ash. The quantities of pollutants entering the environment as a result of coal utilization increase with the steady growth in amount of coal being utilized. There is a definite enrichment of certain elements in the smallest particles emitted from a power plant. These elements include Pb, Tl, Sb, Cd, Se, As, Ni, Cr, Zn and S. The highest concentration of trace constituents occurs in particulate range that can be inhaled and deposited in the pulmonary region of the respiratory system (Tanase *et al.,* 2013). The cases of pulmonary tuberculosis have been found in the Bilaspur district (Source of information about particle size is coal survey centre, Bilaspur, CG). Presently available emission control device for fine particulates are less effective and inefficient for removing particle size range that contains most toxic elements (Macomber and Hausinger, 2011).

Some researchers have been done in the recent past about toxicity of $Al^{3+}$ in plant, water and animal systems (Rahman *et al.,* 2004). In humans, $Al^{3+}$ toxicity may cause Alzemiers disease. In the Bilaspur Industrial area, water from Arpa River contains higher concentration of $Al^{3+}$ than that prescribed by WHO (2010). Against these backdrops, the present study was aimed to analyze the concentration of cadmium, selenium and zink in the water around the industrial area of Chhattisgarh state and its effect on the humans using this water as drinking sources on compression with the healthy controls which are using unpolluted water.

## Materials and methods

Three types of samples were collected in the present investigation and they are:

*Water sampling*: Samples were collected from different polluted sites of rivers and small canals to investigate the actual concentration of toxic metals in the running water and water supplied for irrigation and drinking.

*Blood sampling from polluted area:* The blood samples of 1000 randomly selected individuals from the villages of polluted area who are using polluted water for drinking and daily needs.

*Blood sampling from control sites:* The blood samples of 1000 randomly selected individuals from the non-polluted area who are matched with age sex and socioeconomic values of individuals of polluted area.

*Water analysis:* The principle of analysis is to determine toxic metal using flame atomic absorption spectrometry (Douglas *et al.*, 2004; Tanase *et al.,* 2006). A sample of Insulatard Penfill (3 mL, 100 IU/mL) is acidulated with hydrochloric acid 6N. After 1 h, 1 mL of sample is diluted with hydrochloric acid 0.01N to 50 mL. Total element is determined using flame atomic absorption spectrometry technique based on the following equation:

$$\text{Total element } (\mu g\ mL^{-1}) = \frac{A_{sample}\, C_{std} \quad . \quad b}{A_{std} \qquad\quad a}$$

Where, $A_{sample}$–sample absorbance, $A_{std}$–standard solution absorbance, $C_{std}$–concentration of standard solution measured before sample, µg mL$^{-1}$, a–sample volume pipetted for analysis, mL, b–final volume of sample solution, mL.

*Blood analysis:* All the absorption measurements were carried out as described by Rahman *et al.* (2004). Calibration standard solutions were prepared for each element separately from stock solution in 0.02 N $HNO_3$. Blood samples were diluted accordingly with 0.02 $HNO_3$. The absorbance values of a specific metal were measured by aspirating the solutions in the order of blank, standards, sample blank and samples into the air-acetylene flame employing the optimized conditions (Table 1). A minimum of three absorbance values were recorded for each solution and the mean value of the absorption signal was used for subsequent calculations. The absorption signals were evaluated by subtracting the value of blank from the signal of the sample.

*Statistical analysis:* The data obtained in the study were evaluated using one way ANOVA and student's t-test.

**Results**

The clinical features of samples are given in Table 1 which is showing a similarity between individuals taken for study except the pollution affected area. The present study analyzed the concentration of cadmium, selenium and zink in the water around the industrial area of Chhattisgarh state and its effect on the humans using this water as drinking sources on compression with the healthy controls which are using unpolluted water and the results are given in the Table 2. The study found increased concentration of these three toxic elements in the polluted water as well as in individuals using this water than control which are statistically significant (P<0.0001). The $R^2$ ANOVA (one way) values were 0.9569, 0.9504 and 0.6848 for Cd, Se and Zn respectively. The findings showed a significant increase of toxic metal in the all three groups taken for the study (Water, pollution effected individuals and controls). The present study also investigated the differences of concentration of toxic elements between humans using polluted water than control and the results are presented in Table 3. Present study found statistically significant increase of toxic metals in the blood of polluted individuals than control. We applied student's t-test and found t values 179.9, 115.7, 72.62 for Cd, Se, and Zn respectively.

## Discussion

Toxic metals are disposed into the river by iron and ore industries in this area. The Siltara industrial area in Dharsiwa block at Raipur districts is major producer of fly ash in Chhattisgarh. Transition metal ions have unique property of forming ionic and special type of covalent bond (co-ordinate bond) (Sinha *et al.,* 2013). Hence, plenty of metallo-enzymes are known to act as electron carriers and are involved in the election transfer reactions in the plant and animal systems (Chervona *et al.,* 2012). Over 25% of all enzymes contain tightly bound metal ions or require them for activity (Tokar *et al.,* 2011).

Table 1. Clinical features of polluted and healthy controls.

| Clinical features | Individuals lived in polluted area | Healthy controls (lived in unpolluted area) |
|---|---|---|
| Total number | 1000 | 1000 |
| Sex (Male: Female) | 680:320 | 720:280 |
| Mean BMI ± SD | 24.81 ± 5.39 | 22.75 ± 4.52 |
| Age (Years) | | |
| Mean ± SD | 47.5 ± 5.54 | 49.79 ± 12.66 |
| Age range | 34-56 | 25-78 |

Table 2. Concentration of toxic elements in the polluted water, individuals using this water and control.

| Elements | Conc. in polluted water | Serum conc. of individuals using polluted water | Serum conc. of individuals using unpolluted water | ANOVA |
|---|---|---|---|---|
| Cd | 0.2 | 3.19 ± 0.51 | 0.28 ± 0.04 | $R^2$ = 0.9569 P<0.0001 |
| Se | 2.8 | 1.9 ± 0. 3 | 0.8 ± 0.02 | $R^2$ = 0.9504 P<0.0001 |
| Zn | 17 | 19.95 ± 1.7 | 15.3 ± 1.1 | $R^2$ = 0.6848 P<0.0001 |

Table 3. Differences of conc. of toxic elements between humans using polluted water than control and analyzed by t-test.

| Serum conc. of individuals using polluted water | Serum conc. of individuals using unpolluted water | t-test |
|---|---|---|
| 3.19 ± 0.51 | 0.28 ± 0.04 | t=179.9, P<0.0001 |
| 1.9 ± 0. 3 | 0.8 ± 0.02 | t=115.7, P<0.0001 |
| 19.95 ± 1.7 | 15.3 ± 1.1 | t=72.62, P<0.0001 |

Recent findings suggest that some trace elements contribute to the development of diseases such as ischemic heart disease, hypertension arthritis and cataracts through effects on oxidative metabolism. Nutritional adequacy of $Cu^{2+}$ is of concern in the development of atherosclerosis and ischemic heart disease. Bivalent toxic metals like $Cd^{2+}$ and $Pb^{2+}$ can replace $Zn^{2+}$ or $Cu^{2+}$ from the active enzymatic sites and cause toxicity. Selenium is of concern in the development of cardiomyopathies (e.g. Keshan disease) caused by oxidative damage (Siddiqui *et al.,* 2012). The discharged effluents of power plants, cement and iron ore industries contain several heavy metals which are toxic for cell metabolism in excess concentration in water (Aquino *et al.,* 2012). This water is supplied in to houses for drinking. This water is also using for irrigation of vegetables and grain crops where the excess toxic metals are deposited into edible parts of the plants and become one of the main source of toxic metal into the human blood (House *et al.,* 2008). The individuals living in the pollution effected area were shown higher concentration of toxic metals in their blood.

In this study, the findings are very clear that the control had normal level of toxic metal in their blood. The study find the higher concentration of toxic metals in blood is responsible for various life threatening diseases in the effected individuals below age of 18.

## Conclusion

This study concluded that the impact of toxic metal in water pollution is the main sources of the disease in the individuals living in the polluted areas. The human living in the control sites is less susceptible for the disease. Therefore, the toxic metal water pollution contributes towards disease susceptibility.

## Acknowledgements

The author is thankful to the Principal and HOD Chemistry, Govt. NPG Science College, Raipur (CG) for valuable suggestions and special thank to HOD chemistry ERR PG science college Bilaspur for lab facilities.

## References

1. Aquino, N., Sevigny, M., Sabangan, J. and Louie, C. 2012. The role of cadmium and nickel in estrogen receptor signaling and breast cancer: Metalloestrogens or not? *J. Environ. Sci. Health C. Environ. Carcinog. Ecotoxicol. Rev*. 30(3): 189-224.
2. Chervona, Y., Arita, A. and Costa, M. 2012. Carcinogenic metals and the epigenome: Understanding the effect of nickel, arsenic, and chromium. *Metallomics*. 4(7): 619-627.
3. House, K., Sernetz, F., Dymock, D., Sandy, J. and Ireland, A. 2008. Corrosion of orthodontic appliances: should we care? *Am. J. Orthod. Dentofacial Orthop*. 133(4): 584-592.
4. Macomber, L. and Hausinger, R. 2011. Mechanisms of nickel toxicity in microorganisms. *Metallomics*. 3(11): 1153-1162.
5. Rahman, S., Khalid, N., Ahmad, S., Ullah, N. and Iqbal, M. 2004. Essential trace metals in human whole blood in relation to environment. *Pak. J. Med. Res.* 43(2): 46-51.
6. Siddiqui, M., Ahamed, M., Ahmad, J., Khan, M., Musarrat, J., Al-Khedhairy, A. and Alrokayan, S. 2012. Nickel oxide nanoparticles induce cytotoxicity, oxidative stress and apoptosis in cultured human cells that is abrogated by the dietary antioxidant curcumin. *Food Chem. Toxicol*. 50(3-4): 641-647.
7. Sinha, D., Sharma, S. and Dwivedi, M. 2013. The impact of fly ash on photosynthetic activity and medicinal property of plants. *Int. J. Curr. Microbiol. App. Sci. 2(8):* 382-388.
8. Tanase, I., Popescu, I. and Pana, A. 2013. An analytical method validation for Atomic absorption spectrometry analysis of total zinc from insulin. *Analele UniversităŃii din Bucuresti–Chimie*, Anul XV (serie nouă). (1): 45-50.
9. Tokar, J., Benbrahim-Tallaa, L. and Waalkes, M. 2011. Metal ions in human cancer development. *Met. Ions. Life Sci.* 8: 375-401.