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Human Head Hair as a Tool in Environmental Pollution Monitoring of Agra City

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Massive industrialization and new technologies in all fields, exploitation of natural resources, unplanned construction of roads and buildings, drains, house dust, services of motor vehicles, vehicular traffic, production of metals from ores, sewage, solid wastes, use of more food, fuel, factory discharges, fertilizers, chemicals and human population are the major key factors for environmental pollution in this universe. Most of them are causing the release of toxic pollutants in the environment. Among these toxic pollutants, many acts primarily on the central nervous system of human beings including heavy metals (Rice 1990). Heavy engineering and chemical industry coupled with increase vehicular traffic has posed a serious environmental pollution problems associated with metals. The indiscriminate use of agrochemicals and merciless dumping of heavy metals can acute and long term side effects on living beings.

In developing countries, the chemical industries are proliferating and their harmful effects on the environment are different and higher (WHO Report 1985). Toxicological (Goyer and Mehlam 1977), clinical (Brown and Savory 1983), neurotoxic (Sinha et al. 1993; Sharma 1997), dietary (Underwood 1977) and environmental and/or occupational exposure (Hartwell et al. 1983; Sukumar and Subramanian 2000) aspects of the toxic heavy metals towards human beings have been investigated. In the present study, human head hair has been taken for analyzing the total body burden of heavy metals. Hilderbrand and White (1974) and Flynn (1977) have advocated the use of human hair as an index to evaluate the environmental exposure of humans by toxic heavy metals. Hair is considered to be one of the best indicator for the study as excess of heavy metals in the body are known to be excreted by this route besides other tissues and fluids such as nails, tooth, blood etc (Chuang and Emery 1978; Matsubara and Machida 1985). Specific studies for individual heavy metals in human hair further reveal the usefulness of the easily accessible biochemical sample; concentrations and distribution of toxic heavy metals like mercury (Nord et al. 1973; Jakubezak 1974), lead (Petering et al. 1973; Chattopadhyay et al. 1977), heavy metals (Herber et al. 1983) in hair have been determined to evaluate the levels of environmental exposures. Hair samples have being used as diagnostic tool for pollution measurements and/or occupational exposure of toxic metals, like chromium, zinc, nickel, cadmium etc. (Ellis et al. 1981; Jackson et al. 1982;

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Grandjean 1984; Perrone et al. 1996).

In view of the interest in the distribution of heavy metals in human head hair, a study was conducted in population residing in the various areas of Agra city.

MATERIALS AND METHODS

The population was selected from different areas of Agra city, namely roadside (RS), industrial (I), commercial (C) and remote residential (RR) areas. Hair samples were collected randomly from a total of 354 subjects (194 male and 160 female), ranged in age from 6-60 yr. Each subject was asked to complete a personal questionnaire describing his/her age, domicile, general health, washing, occupation, occupational area and living habits (vegetarian/non-vegetarian, smoker/non-smoker, and alcoholic/non-alcoholic). The samples were procured by normal cutting and collected with care to avoid any external contamination, and sealed immediately in clean and numbered plastic bags after collection and transported to laboratory for further analysis.

Hair sample in each case was cut in the laboratory to about 3 mm lengths to bring it to a uniform size. The sample was then put into 250 ml beaker and washed with deionized double distilled water to remove all the water soluble impurities adhering to hair surface, followed by repeated washing with acetone to remove all organic substance adhering onto hair surface. The washed hair sample was dried at 60°C in an oven before digestion. A gram portion of the dried sample was placed in to a clean 100 ml conical flask; 15 ml of digestion mixture was added to it. The entire sample was digested at 80°C until white fumes came out. After digestion the sample was cooled, dissolved in aqueous N/10 nitric acid and the volume brought to 25 ml in a standard volumetric flask. Heavy metals, cadmium, copper, iron, nickel, lead and zinc, were analyzed by Flame Atomic Absorption Spectrometer (Perkin Elmer AAnalyst 100). The instrumental parameters have been described in the instrumental manual supplied by the manufacturer. Three replicate determinations were made in each case and the analytical data thereby represent means of these measurements. Arsenic and mercury metals were analyzed through Atomic Absorption Spectroscopy following their hydride generation using sodium borohydride reduction method. All the chemicals were used of Merck, AR grade. The results have been reported in μg/g of hair sample.

RESULTS AND DISCUSSION

Arsenic, cadmium, copper, mercury, iron, nickel, lead and zinc concentrations in hair samples of male and female population residing in different areas of Agra city have been summarized in tables 1-4. In case of male population, hair arsenic, iron, mercury, nickel and lead levels were found maximum in the subjects residing near roadside areas. Hair mercury levels have been found much higher in the subjects of roadside areas with a mean concentration of 17.3 μg/g compared to that of other areas. Hair cadmium levels have been observed higher in the

Table 1. Heavy metal contents in male and female hair samples of road side areas of Agra city (μg/g).

Element	Mean concentrations		Range	
	Male	Female	Male	Female
As	0.02	0.007	0.0-0.24	0.0-0.14
Cd	1.8	1.6	0.0-27.5	0.0-21.5
Cu	4.8	8.8	1.2-51.1	0.1-92.1
Fe	454.4	203.5	148.2-756.9	53.0-386.8
Hg	17.3	0.9	0.01-82.3	0.006-15.8
Ni	9.9	6.8	0.6-19.4	0.8-69.3
Pb	11.5	10.1	1.2-162.6	0.08-45.2
Zn	160.0	160.2	68.0-272.5	46.9-401.0

Table 2. Heavy metal contents in male and female hair samples of industrial areas of Agra city (μg/g).

Elements	Mean concentrations		Range	
	Male	Female	Male	Female
As	0.001	0.014	0.0-0.058	0.0-0.07
Cd	4.4	1.6	0.0-18.5	0.0-5.6
Cu	5.5	14.3	0.2-125.0	2.7-24.1
Fe	337.4	136.9	44.1-745.1	53.0-421.3
Hg	0.1	0.2	0.004-0.9	0.0-0.5
Ni	3.6	5.5	0.4-350.2	0.1-25.6
Pb	5.8	3.4	0.3-67.1	0.8-8.0
Zn	160.7	177.8	49.7-461.8	65.8-321.2

population of industrial areas followed by road side, remote residential and commercial areas, respectively. Hair copper and zinc levels were found maximum in the population of remote residential areas.

In case of female population, hair iron, nickel and lead levels have been found maximum in the subjects residing near road side areas. Hair arsenic and copper levels were found higher in the population of commercial areas. Almost similar hair cadmium levels have been observed in road side, industrial and commercial areas with a mean concentration of 1.6 μg/g. Hair mercury and zinc levels have been reported maximum in the population of remote residential areas.

On comparing the metal concentrations of male and female population of various areas of Agra, higher levels of copper, nickel and zinc were reported in female subjects than that of male subjects in all the areas except in commercial areas where hair zinc levels were reported lower in female than that of male.

In this study, the maximum contents for iron, nickel and lead metals were reported in the population residing near road side areas. Hair arsenic and mercury levels were also found maximum in the male population of road side area of Agra city. The higher levels of iron, nickel and lead in hair samples of the population are probably due to the presence of maximum automobile repairing workshops and automobile industries, electroplating industries and vehicular traffic in road side areas. In the female population, hair iron levels were found lower in all the

Table 3. Heavy metal contents in male and female hair samples of commercial areas of Agra city (μg/g).

Elements	Mean concentrations		Range	
	Male	Female	Male	Female
As	0.006	0.016	0.0-0.016	0.0-0.056
Cd	0.8	1.6	0.0-2.9	0.0-5.4
Cu	8.8	23.9	1.7-21.8	1.7-38.7
Fe	203.5	179.9	92.0-447.0	41.7-330.0
Hg	0.5	0.5	0.004-15.0	0.0-2.0
Ni	4.8	6.1	0.2-85.6	0.6-10.6
Pb	6.3	9.0	0.06-15.5	0.7-41.7
Zn	174.6	169.6	56.0-355.2	53.4-329.6

Table 4. Heavy metal contents in male and female hair samples of remote residential areas of Agra city (μg/g).

Elements	Mean concentrations		Range	
	Male	Female	Male	Female
As	0.009	0.007	0.0-0.58	0.0-0.019
Cd	1.0	1.0	0.0-2.5	0.0-1.8
Cu	9.0	14.7	0.1-34.2	3.2-26.7
Fe	240.8	181.3	25.8-492.9	30.3-414.4
Hg	1.1	1.12	0.0-17.5	0.0-28.0
Ni	7.0	6.5	0.2-20.1	1.1-33.9
Pb	5.2	6.6	0.05-19.0	0.07-32.4
Zn	187.0	187.4	56.5-367.9	80.8-401.0

four areas of Agra, which may be coincident with the menstrual cycle. The values of lead in hair have been observed less compared to those reported earlier studies (Hammer et al. 1971; Ahmad et al. 1988; Sharma 1997). The values of zinc have been observed also less compared to those reported by Ahmad et al (1988).

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