Journal of Medical Sciences

ISSN 1682-4474

Research Paper

JMS (ISSN 1682-4474) is an International, peer-reviewed scientific journal that publishes original article in experimental & clinical medicine and related disciplines such as molecular biology, biochemistry, genetics, biophysics, bio-and medical technology. JMS is issued eight times per year on paper and in electronic format.

For further information about this article or if you need reprints, please contact:

K.F. Abed
Girls College Presidence Agency, P.O. Box 75407, Riyadh 11578, Saudi Arabia

Tel: +966-1-470-6790
Fax: +966-1-470-6790

J. Med. Sci., 7 (2): 263-266
15th February, 2007

Aluminum, Cadmium and Microorganisms in Female Hair and Nails from Riyadh, Saudi Arabia

[1]A.R. Hashem and [2]K.F. Abed

Mineral analysis from hair and nails may be useful in knowing the elemental concentration in body tissue. This study was conducted to ascertain levels of aluminum, cadmium and microorganisms in hair and nails from 20 adult Saudi women aged between 20-25 years old from Riyadh, Saudi Arabia between December 2005 and January 2006. Metal analysis were carried out by Atomic Absorption Spectroscopy (AAS) using Electrothermal atomization (Pye Unican Sp[9]) and done according to Ellis, Ramirez, Buchanan and Gibbons methodology. The levels of aluminum was 5.23±1.31 to 26.02±3.65 $\mu g\ g^{-1}$ and cadmium was 0.04±0.01 to 0.014±0.002 $\mu g\ g^{-1}$ in hair and nail samples. Aluminum is more significantly concentrated in the nails than hair ($p<0.0001$). Cadmium levels were significantly higher in hair than in nails ($p<0.0001$). However, levels of aluminum are higher in both hair and nail samples compared to cadmium ($p<0.0001$). These levels are much lower compared to reports from other countries like Spain, Germany, Norway and USA. Microbial isolates revealed *Microsporum*, *Staphylococcus*, *Klebsiella*, *Bacillus* and *Pseudomonas*. Fungal isolates included *Penicillium*, *Trichophyton* and *Aspergillus*. These are all known bacterial and fungal isolates from the soil. Despite lower level findings of aluminum and cadmium compared to other countries, further information is needed on concentrations of elements in the hair of individuals with known exposures to trace elements. Our levels are within the worldwide range for normal occupationally exposed population despite the booming economic growth and rapid industrialization of Saudi Arabia.

Key words: Aluminum, cadmium, hair, nails, Saudi Arabia

ANSInet
Asian Network for Scientific Information

[1]College of Science, King Saud University, P.O. Box 2455, Riyadh, Saudi Arabia
[2]Girls College Presidence Agency, P.O. Box 75407, Riyadh 11578, Saudi Arabia

INTRODUCTION

Toxic heavy metals, including Aluminum and Cadmium may be the biggest health threat of the new millennium and become an increasingly major health problem since the industrial revolution. Heavy metals are in the water we drink, the foods we eat, the air we breathe, our daily household cleaners, our cookware and our daily tools (Biddle, www.breathing.com). As levels rise in air, water and topsoil, they also rise within our bodies, contributing to chronic diseases, cancer, dementia and premature aging. Heavy metals poison us by disrupting our cellular enzymes, kick out the nutrients and bind their receptor sites, causing diffuse symptoms by affecting nerves, hormones, digestion and immune function (Emedicine.com-topic 271).

Metals are redistributed naturally in the environment by geologic, biologic and human activities that accumulate in soil, water and air then enter the food chain which probably represent the largest source of exposure (Hashem, 1995; Vallee and Ulmer, 1972).

Aluminum occurs naturally and makes up about 8% of the surface of the earth. It is always found combined with other elements such as oxygen, silicon and fluorine When aluminum enters into the environment, it binds to particles in the air. It can dissolve in lakes, streams and rivers depending on the quality of water. It can also be taken up into some plants from soil however, it is not known to bioconcentrate up the food chain (US Environmental Protection Agency, 1979). Younger populates in Holland have higher hair content of aluminum (Zakrgynska-Fontaine *et al*., 1998).

People who are exposed to high levels of aluminum in air may have respiratory problems including cough and asthma from breathing dust. Some studies show that people with Alzheimer's disease have more aluminum than usual in their brains. The Environmental Protection Agency (EPA) of the United States recommends that the concentration of aluminum in drinking water not exceed 0.2 parts of aluminum per million parts of water (0.2 ppm) because of aesthetic effects, such as taste and odor problems. Currently, the blood levels of aluminum should not exceed 10 ppb (Agency for Toxic Substances, www.atsdr.cdc.gov).

Cadmium is a natural element in the earth's crust. It is usually found as a mineral combined with other elements such as oxygen (cadmium oxide), or sulfur (cadmium sulfate, cadmium sulfide. Tobacco smoking is associated with increased Cadmium levels in hair and nails of men and women (Sukumar and Subramanian, 1962). It can stay in the body for a very long time and can build up from many years of exposure to low levels. Breathing high levels of cadmium severely damages the lungs and can cause death. Eating food or drinking water with very high levels severely irritates the stomach, leading to vomiting and diarrhea. Long-term exposure to lower levels of cadmium in air, food or water leads to a build-up of cadmium in the kidneys and possible kidney disease. Other long-term effects are lung damage, fragile bones, nerve and brain damage. The Occupational Safety and Health Administration (OSHA) limits workplace air to 100 µg cadmium per cubic meter (100 $\mu g\ m^{-3}$) as fumes and 100 µg cadmium/m^3 as cadmium dust (www.atsdr.cdc.gov).

Air, water, soil, plants and animals are clear routes by which human beings come into contact with heavy metals and microorganisms (Hashem, 1995; Hashem and Othman, 2001). *Aspergillus*, *Penicillium* and *Chrysosporium* sp. were the most predominant fungi in hair (El-Said, 1996). Little attention has been paid especially dealing with heavy metals and microorganisms in the human body in Saudi Arabia (Azhari and El Mubarak, 1990).

This study was conducted similarly in line with previous studies done by Hashem (1995) Hashem and Othman (2001), Jarallah *et al*. (1993) and Al-Nasser and Hashem (1996). These previous studies however were not able to determine the levels of aluminum and cadmium in hair and nails, of which we deemed of similar importance. This study aimed to determine the levels of aluminum and Cadmium in female hairs and nails collected from samples around Riyadh City, Saudi Arabia. Furthermore, we also aimed to determine what microorganisms are present in the hair and nail samples. This would however further augment findings of trace elements and heavy metals in human hair and nails which would indicate exposure and even toxicity.

MATERIALS AND METHODS

Hair and nail samples were collected from 20 adult women aged between 20-25 years old from Riyadh, Saudi Arabia between December 2005 and January 2006. Samples were then sent to the laboratory for metal analysis and microbial isolation.

Heavy metal analysis: Several snips of hair are cut close to the scalp. The ends over three millimeters long are cut off and thrown away, as these would give a bad reading. Hair should have been washed within 48 h of taking the sample. A required 500 mg or about a table spoon each of hair and nail samples was needed. These were cut into small pieces and were added separately to 10 mL of concentrated nitric acid to dissolve the samples overnight. The next day, the samples were heated moderately under refluxing for complete digestion. The ash produced by wet decomposition was dissolved in diluted nitric acid. Solution was added with deionized water to complete a total volume of 10 mL. The undissolved residue was removed by centrifugation at 200 rpm for 5 min and supernatants were stored in plastic vials in the refrigerator. Samples were measured using electrothermal Atomization on an Atomic Absorption Spectrophotometer (Pye Unican Sp9) equipped with graphite furnace and video computer program (Al Nasser and Hashem, 1996). Each mineral gives off characteristic colors or spectra, which are read by sensitive detectors. Controls are run with each batch of sample. The entire batch is discarded if the controls are not within normal values.

Microbial analysis: Microbial isolation of hair and nails were carried out using Petri dishes containing nutrient agar and malt extract agar for bacterial growth. Microbial isolates were identified using the Ellis, Ramirez, Bermojo-Barrera method.

RESULTS AND DISCUSSION

Hair and Nail samples from 20 adult Saudi women with mean age of 22.3±1.2 years (range 20-25 years old) were analysed for aluminum, cadmium and microbial isolates. Cadmium and aluminum content from hair and nail samples of subjects are listed in Table 1. Aluminum showed to be more significantly concentrated in the nail samples (26.019±3.65 μg g^{-1}) compared to hair samples (5.228±1.31 μg g^{-1}) ($p<0.0001$). Cadmium levels were significantly higher in hair samples than in nail samples (0.035±0.007 vs 0.014±0.002 μg g^{-1}, $p<0.0001$). Aluminum contents are more significantly concentrated in the hair and nail samples compared to cadmium ($p<0.0001$).

Microbial isolates are listed in Table 2. These included species of *Bacillus*, *Klebsiella*, *Microsporum*, *Staphylococcus*, *Pseudomonas* and the fungal species of *Aspergillus*, *Penicillium* and *Trichophyton*.

Comparing our results with other countries, our mean aluminum concentration in hair is much less than that reported in Spain, Germany and Norway (AlNasser and Hashem, 1996; Wing-Oystein *et al*., 1999; Ack *et al*., 1996). Generally, our reported levels are even lower than those reported from some industrialized cities in the USA and other parts of the world (Ghannoum *et al*., 2000; Danile and Elewski, 2000; Brooks *et al*., 1995; Eads and Lambdin, 1973; Bate and Doyer 1965). It is within the worldwide range for normal occupationally exposed population (Hashem and Othman, 2001).

Table 1: Aluminum and cadmium concentration in hair and nails of some Saudi women from Riyadh, Saudi Arabia (n = 20)

Hair (μg g^{-1})		Nails (μg g^{-1})	
Aluminum	Cadmium	Aluminum	Cadmium
5.228±1.31	0.035±0.007	26.019±3.65	0.014±0.002

Results expressed in mean±SD

Table 2: Microflora isolated from hair and nails of some Saudi women from Riyadh, Saudi Arabia (n = 20)

Hair	Nails
Bacteria	Bacteria
Bacillus sp.	*Staphylococcus* sp.
Klebsiella sp.	
Staphylococcus sp.	
Pseudomonas sp.	
Fungi	Fungi
Aspergillus sp	*Microsporum* sp.
Penicillium sp.	*Penicillium* sp.
Trichophyton sp.	*Trichophyton* sp.
Micrsoporum sp.	

However, these results need to be revisited soon since Saudi Arabia in the last few years has experienced rapid industrialization and economic boom. Lifestyle of citizens has changed including the modernization of infrastructures, equipments and even industries. Several industries were built and cars on the streets have doubled or even tripled in number increasing the tendency of it's populates to environmental hazards. Considering the information and results that we have gathered so far, we are optimistic to pursue more investigations on this subject matter on a larger scale comparing the exposed and the non-exposed areas of Saudi Arabia.

REFERENCES

Ack, M., Z. Yunhong, M. Po Keing, Y.H. Zheng and P.K. Mak, 1996. Trace elements in scalp hair and of professional drivers and university teachers in Hongkong. Biol. Trace Elem. Res., 53: 241-247.

Agency for Toxic Substances and Disease Registry, Division of Toxicology. www. atsdr.cdc.gov.

AlNasser, I.A. and A.R. Hashem, 1996. Lead, zinc and copper concentration in hair, nails and blood of workers in Saudi Arabia. J. King Saud Univ. Sci., 10: 95-100.

Azhari, A.M. and A.H. El Mubarak, 1990. Lead and cadmium in human hair. A comparison with other countries. Bull. Environ. Contam. Toxicol., 40: 139-147.

Bate, L.C. and F.F. Doyer, 965. Trace elements in human hair. Nucleonics, 23: 45-46.

Bermojo-Barrera, P.A., J. Poreda-Piniero and Moreda-Piniero, 1998. Determination of aluminum and manganese in human scalp hair by electrothermal atomic absorption spectrophotometer using slurry sampling. Atlanta Oxford, 45: 1147-1154.

Biddle, J., Optimal Breathing. Toxic Metals-Pandora's Box. www.breathing.com.

Brooks, G.F., J.S. Butel and N. Ornston, 1995. Medical Microbiology. Prentice Hall, New Jersey.

Danile, C.R. and B.E. Elewski, 2000. The diagnosis of nail fungus. Infect. Rev. Arch. Derma, 136: 1762-1764.

Eads, E.A. and C.E. Lambdin, 1973. A survey of trace metals in human hair. Environ. Res., 6: 247-252.

Ellis, M.B., 1971. Dematiaceous Hypomycetes. Commonwealth Mycological Institute. Kew, Surrey, England.

El-Said, A.H.M., 1996. Isolation of fungi from human hair samples collected in Bahrain and the antifungal activity of various shampoos. Cryptogamie Mycol., 17: 39-46.

Ghannoum, M.A., R.A. Hajjeh, R. Scher, M. Konnikor and A.K. Gupta, 2000. A large scale North American study of fungal isolates from antifungal susceptibility patterns. J. Am. Acad. Derma, 43: 64-68.

Hashem, A.R., 1995. Soil analysis and mycoflora of the Jubail Industrial city in Saudi Arabia. J. Kuwait (Sci.), 22: 231-238.

Hashem, A.R. and M.R. Othman, 2001. Hair and Nail levels of iron of healthy volunteer women from Saudi Arabia. The Science, pp: 28-29.

Jarallah, J., K. Noweir, S. Shamma, I. AlSaleh, M. AlZahrani and M. AlAyed, 1993. Lead exposure among school children in Riyadh, Saudi Arabia. Bull. Environ. Contam. Toxicol., 50: 730-735.

Ramirez, C., 1982. Manual and Atlas of Penicilia. Elsevier Biomedical Press Amsterdam.

SuKumar, A. and R. Subramanian, 1962. Elements in hair and nail of residents from a village adjacent to New Delhi. Influence of place of occupation and smoking habits. Biol. Trace Elem. Res., 34: 99-105.

Toxicological profile for Cadmium. Agency for Toxic Substances and Disease Registry. www. atsdr.cdc.gov.

US Environmental Protection Agency, Research and Development. Toxic Trace Metals in Mammalian and Human Hair and Nails. August, 1979.

Vallee, B.L. and D.D. Ulmer, 1972. Biochemical effects of Mercury, Cadmium and Lead. Ann. Rev. Biochem., 41: 91-128.

Wing-Oystein, R., A. Renzoni and I. Gjertz, 1999. Levels of cadmium and mercury in the hair of atlantic walruses (*Odobenus rosmarus*) from Svalbard, Norway. Polar Biol., 21: 343-346.

www.emedicine.com/emerg/topic271

Zakrgynska-Fontaine, V. *et al.*, 1998. Study of the age and sex dependence of trace elements In hair by correspondence analysis. Biol. Trace Elem., 61: 151-168.