Determination of essential heavy metal levels of Fe, Zn and Cu in hair samples of anemic patients due to iron deficiency and chronic disorders

N D Kumarage[1], N S Amarasinghe[2], C D Jayaweera[1*], H J M B R Jayaratne[2], M M Gunathilaka[2],
L S Liyanage[2], P T Wijesena[2], M H J D Ariyaratne[2]

[1]Department of Chemistry, University of Sri Jayawardenepura
[2]Department of Pathology, National Hospital Sri Lanka
*Email: champa.jayaweera@gmail.com

Iron deficiency anaemia is one of the most common forms of anaemia abundant in all regions of the world.[1] The role of iron in haemopoiesis has been studied widely and trace metals such as Cu and Zn have certain functions in normal haemopoiesis.[2,3] There had been very few studies related to impact of these metals in the process of haemopoiesis and development of anaemia. Higher concentrations of elements in hair are an indication of their bio accumulation over a long period of deposition.[4] Analysis of iron in blood is commonly used in order to determine the cause of anemia however analytical methods are not available to diagnose the anemic condition caused by other trace elements.

The study was designed to assess the levels of essential trace elements in hair samples of anemic and control subjects in Sri Lanka, and to correlate the level of these elements with the occurrence of anemia. The effects of age and sex on the levels of essential elements in the hair samples were also investigated.

Scalp hair samples were collected from 65 anemic patients and 50 controls with age range 20 to 80 years of both genders in the hematology clinic of National Hospital of Sri Lanka after screening through by a questionnaire. The elements Cu, Zn and Fe in the hair samples were measured by flame atomic absorption spectrophotometry (iCE 3000) after wet acid digestion. The proposed analytical method was validated using hair samples of control subjects.

A detection limit of 0.019 ppm, 0.044 ppm and 0.015 ppm were obtained for Cu, Fe and Zn, respectively. Overall percentage of recovery studies of each element was Fe 97.40%, Cu 99.00% and Zn 97.20%. Statistical analysis were conducted to determine statistical significance differences between concentrations of elements reported in the hair samples of both anemic patients and controls at 5% level of significance. Overall mean concentration of Zn (294.3 ± 33.4 mg/kg), Fe (487.6 ± 76.8 mg/kg) and Cu (57.4 ±

9.7 mg/kg) were found in control subjects and Zn (135.2 ± 80.9 mg/kg), Fe (118.7 ± 51.1 mg/kg) and Cu (18.6 ± 8.3 mg/kg) were found in anemic subjects. The above results indicate significantly lower concentration of Cu, Zn and Fe in anemic subjects compared to control subjects (p=0.000). According to the results, the hair element content highly depends on the health status of the human body. The levels of all the elements analyzed were statistically higher in male subjects compared to female subjects (p=0.000). Overall element concentration of Cu (58.7 ± 9.7 mg/kg), Zn (295.7 ± 30.0 mg/kg) and Fe (486.7 ± 51.6 mg/kg) were found in male and Cu (56.6 ± 9.5 mg/kg) Zn (293.3 ± 35.5 mg/kg) and Fe (485.7 ± 86.3 mg/kg) were found in female subjects. Results reflect a wide variation in essential trace element concentration of Cu, Zn and Fe in human hair in male and female. It could be due to individual differences in exposure to the environment and different occupations. The mean element levels of Cu, Zn and Fe were higher in control subjects compared to anemic in all age groups (p=0.000). The changing metabolic processes inside the human body with increasing age may be responsible for different element concentrations among different age groups.

There is a clear evidence of the deficiency of copper and zinc levels to anemic condition in human body other than iron. In addition, the trace element concentrations were highly dependent on age and sex. It can be concluded that the results in this study confirmed the usefulness of hair element analysis in screening tests for the assessment of the cause of anemia in male and female subjects.

Reference

1. McLean, E., Cogswell, M., Egli, I., Wojdyla, D., de Benoist, B., 2009, *Public health nutrition* **12** (04), 444-454.
2. Ganz, T.; Nemeth, E., 2006, *American Journal of*