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Full Length Research Paper

Comparative analysis of zinc, copper, chromium, iron and manganese among pregnant, unmarried and menopausal females using hairs as biomarkers

Aima Iram Batool[1], Naima Huma Naveed[1]*, Fayyaz Ur Rehman[2], Aamir Ali[1], Muhammad Ilyas Tariq[2], Shazia Irfan[1], Tasawwur Ali[1], Naima Iram[1] and Nabiha Riaz[1]

[1]Department of Biological Sciences, University of Sargodha, Sargodha, Pakistan.
[2]Department of Chemistry, University of Sargodha, Sargodha, Pakistan.

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Environmental changes as well as a worsening environmental quality, strongly affect women lives. A woman goes through a wide range of changes throughout her lifetime, from fetal development through her post-menopause years, which involves a direct relationship between body metallic ion concentration and development and function. When this relationship is balanced, it helps to create conditions for good health. However, when this relationship is out of balance, it can lead to a range of health problems that can be painful and devastating. With exposure, women and girls are at greater risk for developing reproductive health problems including early puberty, uterine fibroids, endometriosis, polycystic ovarian syndrome (PCOS) and breast cancer. These health problems can be devastating to woman's fertility, overall health and quality of life. In this scenario, the present investigation study was carried out to analyze the concentration of different metallic elements in female body by using scalp hairs. Hairs being noninvasive material are good indicator of metallic element in human body. Three categories of females viz. unmarried, pregnant and menopause were selected. Concentration of iron, copper and zinc were found lower among pregnant ones as compared to unmarried and menopausal females. Moreover, concentration of iron, zinc and copper were significantly higher among unmarried females.

Key words: Pregnant, unmarried, menopause, hairs.

INTRODUCTION

Females are at greater health risk in developing countries due to inadequate nutrition, unhealthy lifestyle and environmental deterioration (Batra and Seth, 2002). Health issues related to females are important because, they are the foundation stone of the whole society in general and for the family in particular. Females passed for altered phases seeing adolescence till menopause. During these phases, their figure physiology changes in terms of change in volume of body fluid, change in concentration of essential metallic ions and change in hormonal and enzymatic level etc. knowledge about metallic elements in females body is important in this regard because they are part of whole body machinery and their deficiency, excess or any imbalance leads towards different disorders.

Physiological changes also alter the bioaccumulation pattern of these metals in female body. Most of the metals act as endocrine disrupters interfering with female hormonal system. Women and girls are particularly sensitive to the effects of hormone disruption during specific stages of rapid hormone driven development. The female menstrual cycle is highly regulated by a variety of hormones. Hormone disruptors can interfere with menstruation through multiple pathways, resulting in irregular periods, shorter or longer cycles, and fertility problems (Crain et al., 2008). Pregnant women are more susceptible in terms of fetus safety. Deficiency and

*Corresponding author. E-mail: naimahuma@yahoo.com. Tel: + 923216077929.

excess of many metallic element is associated with impaired growth, skeletal defects, reduced reproductive function, abnormal glucose metabolism, altered lipid and carbohydrate metabolism, adverse neurological, reproductive, respiratory effects (Aschner et al., 2005) and low birth weight deliveries (Ugwuja et al., 2011). Older females as compared to younger ones are at high risk of nutritional deficiency of micro nutrients. Intake requirements of minerals vary according to the period of growth, menstruation, pregnancy, lactation, menopause and illness.

Hair mineral analysis of human females having different physiological condition (pregnancy, lactation, menstruation and menopause) has the potential to give information, regarding their health status of the concerned person. Hair mineral concentration act as useful diagnostic tool for detection of deficiencies, excess or imbalance of trace elements. This is very important from health point of view because imbalance of trace minerals can also lead to the disturbance of metabolism, ill health, undesirable weight gain, and weak immune system (Viteri and Ames, 2003). It is therefore important to determine the trace minerals concentration in the humans especially females, to monitors and assess their impact on human health.

The present investigation was carried out in order to determine the concentration of different minerals in the hair samples of female residents of Sargodha district. The study area selected is contaminated with heavy metal pollution as reported previously by Naveed et al. (2010) and Batool et al. (2011). Females were categorized on the basis of age and physiological conditions viz. pregnant, unmarried and menopause.

MATERIALS AND METHODS

The present investigation was conducted on female individuals residing in Sargodha district. Subjects under study were categorized into three groups; unmarried, pregnant and menopausal based on their physiological condition. Information regarding dietary habits, medical history and physiological conditions were collected through questionnaires. Fifty females for each category, pregnant females with first trimester were selected. All were apparently healthy females.

Two grams hair sample was taken from different areas of head by using stainless steel scissor from each subject. Only those samples on which no dye or any hair color was used were collected. Each sample was soaked into double distilled water with continuous stirring for half an hour to remove externally attached dust particles and other contamination that might also contain trace metals. After washing, samples were oiled for few minutes and dried between filter papers. Then 500 mg from each sample was taken and subjected to wet acid digestion using nitric and perchloric acid (Mehra and Juneja, 2005). After the attainment of water clear solution, samples were removed from hot plate for cooling. Cooled samples were transferred to volumetric cylinders and volume was made up to 25 ml with the help of deionized water. Then solutions were transferred into marked Teflon bottles. Finally, samples were run through Atomic absorption spectrophotometer for determination of Fe, Cr, Mn, Cu and Zn.

Statistical analysis

SPSS and XLSTAT programs were used to compute out analysis of variance and graphical presentation. Correlation studies were carried out by using Pearson's correlation coefficient.

RESULTS

Statistically significant difference at $p < 0.05$ was observed among all the groups for Cu concentration in hair samples. Cu hair concentration in pregnant, unmarried and menopause ranged from 8.10 to 13.94, 4.97 to 14.935 and 8.205 to 12.89 µg/g, respectively. The unmarried had highest values of copper as 11.27 ± 2.47 allegorized to pregnant (10.114 ± 1.366) and menopausal ones (10.229 ± 1.044) (Figure 1). Figure 1 also depicts the average value of iron concentration in hair samples of unmarried, pregnant and menopause females. Concentration of iron was significantly higher among unmarried females (2.224 ± 0.053) as compared to the other two categories. Maximum range of Fe hair concentration in unmarried was 2.3001 and minimum range was 2.1290 µg/g. For menopause and pregnant ones, Fe concentration ranged from 0.6319 to 2.3684 µg/g and 0.8901 to 2.4115 µg/g, respectively.

Lowest chromium concentration was observed in hair samples of expecting females (0.46 ± 0.0039) matched to unmarried (0.341 ± 0.03) and menopausal females (0.45 ± 0.018). Analysis of variance divulged significantly higher manganese concentration (0.279 ± 0.037) in hair samples of menopause females matched to unmarried (0.119 ± 0.013) and pregnant ones (0.221 ± 0.02). Furthermore, Zn hair concentration value varied from 18.07 to 111.5 µg/g for menopausal females, 28.39 to 122.13 µg/g for unmarried ones and 13.515 to 49.95 µg/g for pregnant ones. All groups were observed to be suffering from Zn deficiency. Statistically significant difference was present for Zn concentration in hair samples of unmarried, pregnant and menopause (Figure 1).

DISCUSSION

The present investigation of biological samples (hair) depicted significant differences among unmarried, pregnant and menopause females for different metallic elemental concentration. Among pregnant females, concentration of chromium and zinc were higher allegorized to the other two categories. Accumulation of iron and copper were higher in the hair samples of unmarried ones while in menopausal females, manganese accumulation was higher allegorized to pregnant and unmarried ones. Iron cation is crucial for the delivery of oxygen within the body through interactions with hemoglobin and myoglobin. Iron is also the main part of cytochrome C which is responsible for electron transfer

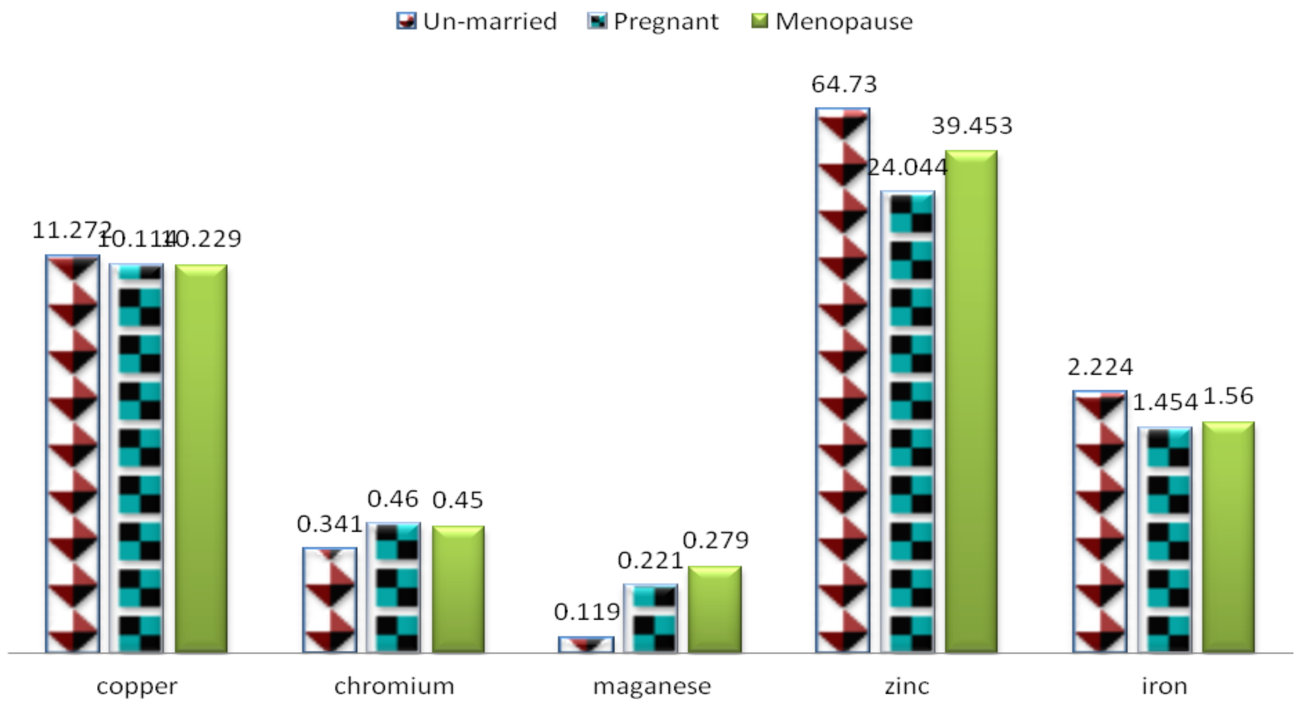

Figure 1. Comparative analysis of metals among unmarried, pregnant and menopausal females.

within mitochondria. Therefore, a high iron concentration may have an indirect impact on fatty acid oxidation and ATP production in mitochondria (Griffith, 1995; Clement, 1994). The quantification of hair Iron may be useful to complement evaluation of the body iron status (Bisse et al., 1996). The case of Fe concentration in hair varied from 0.631 to 2.4115 µg/g much lower than reported values (19 mg/kg by Senofenote, 2000) showing iron deficiency among females under study.

We also observed higher chromium level during pregnancy, which was contrary to Hambidge and Rodgerson (1971), who reported that chromium decrease in pregnancy, particularly in multiparous women. Manganese is recognized as playing an important role in the functioning of isocitric dehydrogenase, an important control enzyme in the regulation of Krebs cycle (Harper, 1979). Additionally, manganese is involved in the interconversion of phenylalanine into thyroxin (Everson and Shraier, 1968), which in turn regulates the intestinal absorption of glucose (Bland, 1979). Higher demand during pregnancy leads to increased body levels. These findings suggest that lifestyle and environmental factors may interfere with the delicate balance and homeostatic mechanisms required to maintain Mn at optimal levels for physiological changes during pregnancy (Takser et al., 2004). Senofonte et al. (2000) worked out the values of Mn in hair as 0.35 mg/kg, while khalique et al. (2005) as 0.011 µg/g, both of which are in agreement with our values (0.02 to 0.355 µg/g). Another study carried out by Batool et al. (2011) found Mn concentration as 0.31 µg/g in hair samples of males in the same area that is presently under study.

Copper is a female element because it is needed more for certain functions in women. It is extremely important for women's fertility and sexual function, and its level often varies up and down with the level of estrogen. Too much of copper causes a wide variety of common symptoms, especially for women such as, fatigue, acne, migraine headaches, moodiness, ADD, ADHD, autistic tendencies in babies and children, infertility and premenstrual tension. Copper deficiency during embryonic and fetal development has been found to cause numerous gross structural and biochemical abnormalities (Ebbs et al., 1994). We observed copper in the range of 4.97 to 14.93 µg/g which was in agreement with Popko et al. (2003) who reported copper concentration in females' hairs in the range of 5.14 to 21.32 µg/g.

Zinc is also known to affect growth, development and reproduction. Its deficiency leads to the deterioration of many metabolic functions, and it is necessary during life periods of growth and cell differentiation, such as pregnancy (Camara, 2003). Zinc level was lower in pregnant (24.044 µg/g) females as compared to unmarried (64.73 µg/g) and menopausal females (39.45 µg/g). We observed zinc decline during pregnancy, which may be due to hormonal suppression and iron-folate supplementation which reduces zinc absorption (krajewski et al., 2009). Zinc reserves return to normal shortly after delivery. Zinc as the component of several enzymes is very important to fetal growth. Its deficiency in newborn

Table 1. Correlations among metallic elements in hair samples of pregnant females.

Parameter	Element		Zinc	Copper	Chromium	Manganese	Iron
	Zinc	Correlation Coefficient	1.000				
		Sig. (1-tailed)					
	Copper	Correlation Coefficient	-0.054	1.000			
		Sig. (1-tailed)					
Spearman's rho	Chromium	Correlation Coefficient	-0.125	-0.148	1.000		
		Sig. (1-tailed)					
	Manganese	Correlation Coefficient	0.316	-0.381*	-0.132	1.000	
		Sig. (1-tailed)					
	Iron	Correlation Coefficient	-0.103	0.280	-0.112	-0.545**	1.000
		Sig. (1-tailed)					

*Correlation is significant at the 0.05 level (1-tailed); **correlation is significant at the 0.01 level (1-tailed).

Table 2. Correlations among metallic elements in hair samples of unmarried females.

Parameter	Element		Zinc	Copper	Chromium	Manganese	Iron
	Zinc	Correlation Coefficient	1.000				
		Sig. (1-tailed)					
	Copper	Correlation Coefficient	-0.068	1.000			
		Sig. (1-tailed)					
Spearman's rho	Chromium	Correlation Coefficient	0.036	0.223	1.000		
		Sig. (1-tailed)					
	Manganese	Correlation Coefficient	0.285	-0.270	-0.069	1.000	
		Sig. (1-tailed)					
	Iron	Correlation Coefficient	0.024	-0.019	0.151	0.089	1.000
		Sig. (1-tailed)					

can be reason for intrauterine growth restriction (IUGR), congenital anomalies, nail hypoplasia or dysplasia and dermatitis.

In addition, Spearman's correlation revealed inverse relationship between copper and iron among all categories (Tables 1 to 3). Manganese was negatively correlated with chromium, but positively with zinc among unmarried and pregnant females. Negative relationship between zinc and iron was also observed among pregnant and menopausal females.

Table 3. Correlations among metallic elements in hair samples of menopausal females.

Parameter	Element		Zinc	Copper	Chromium	Manganese	Iron
Spearman's rho	Zinc	Correlation Coefficient	1.000				
		Sig. (1-tailed)					
	Copper	Correlation Coefficient	0.118	1.000			
		Sig. (1-tailed)					
	Chromium	Correlation Coefficient	-0.269	-0.338*	1.000		
		Sig. (1-tailed)					
	Manganese	Correlation Coefficient	-0.087	-0.002	0.009	1.000	
		Sig. (1-tailed)					
	Iron	Correlation Coefficient	-0.118	-0.136	0.206	-0.214	1.000
		Sig. (1-tailed)					

*Correlation is significant at the 0.05 level (1-tailed).

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